

*THE UNO AVIATION MONOGRAPH SERIES*

UNOAI Report 98-3

**The Symposium Proceedings of the 1998  
Air Transport Research Group (ATRG)**

Volume 1

Editors

Aisling Reynolds-Feighan

Brent D. Bowen

November 1998

**UNO**

**Aviation Institute**

**University of Nebraska at Omaha**

**Omaha, NE 68182-0508**



000000  
57

**The University of Nebraska at Omaha  
Aviation Institute  
Monograph Series**

**Mission**

The UNO Aviation Institute Monograph Series began in 1994 as a key component of the education outreach and information transfer missions of the Aviation Institute and the NASA Nebraska Space Grant & EPSCoR Programs. The series is an outlet for aviation materials to be indexed and disseminated through an efficient medium. Publications are welcome in all aspects of aviation. Publication formats may include, but are not limited to, conference proceedings, bibliographies, research reports, manuals, technical reports, and other documents that should be archived and indexed for future reference by the aviation and world wide communities.

**Submissions**

Aviation industry practitioners, educators, researchers, and others are invited to submit documents for review and possible publication in the monograph series. The required information is listed in the Submission Checklist, found on the world wide web at:

<http://cid.unomaha.edu/~nasa>

Select UNOAI Monograph Series, select Submission Checklist.

**Dissemination**

The UNO Aviation Institute Monograph Series is indexed in various databases such as Educational Research Information Clearinghouse (ERIC), Transportation Research Information Services (TRIS), Aviation TradeScan, NASA Scientific & Technical Reports (STAR), and the Library of Congress. The series is also cataloged in the UNO Library, which is a member of the Online Computer Library Center (OCLC), an international bibliographic utility. OCLC's Union Catalog is accessible world wide and is used by researchers via electronic database services EPIC and FirstSearch and is also used for interlibrary loans. In addition, copies have been provided to the University of Nebraska - Lincoln and the University of Nebraska at Kearney Libraries. Copies are also provided to the Nebraska Library Commission, the official archive of state publications.

**Ordering**

UNO Aviation Institute monographs are available from the UNO Aviation Institute, Allwine Hall 422, 6001 Dodge Street, Omaha, NE 68182-0508. Order information is also available on the world wide web at <http://cid.unomaha.edu/~nasa> select UNOAI Monograph Series.



# University of Nebraska at Omaha Aviation Institute

## Aviation Monograph Series

---

Recent monographs in the series include:

- 98-6 thru 98-9     The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society
- 98-3 thru 98-5     The Symposium Proceedings of the 1998 Air Transport Research Group
- 98-2     Aviation Security: Responses to the Gore Commission
- 98-1     The Airline Quality Rating 1998
- 97-9     The Airline Quality Rating 1997
- 97-2 thru 97-8     The Conference Proceedings of the 1997 Air Transport Research Group (ATRG) of the WCTR Society
- 97-1     Aviation Institute Self Study Report for the Council on Aviation Accreditation
- 96-4     The Airline Quality Rating 1996
- 96-3     NASA and Ethics: An Annotated Bibliography
- 96-2     The Image of Airport Security: An Annotated Bibliography
- 96-1     Concentration and Contestability in the Deregulated United States Airline Industry
- 95-2     The Nebraska Initiative for Aerospace Research and Industrial Development
- 95-1     Nebraska Space Grant Consortium: 1993-1994 Self Evaluation (no longer available)
- 94-5     Proceedings of the First Annual Nebraska Aviation Education Association Conference
- 94-4     Training Program for Latvian Public and Aviation Administrators
- 94-3     Samantha Smith Memorial Exchange Between The University of Nebraska at Omaha and Riga Aviation University
- 94-2     Interactive Learning: The Casewriting Method as an Entire Semester Course for Higher Education Teacher's Manual
- 94-1     Interactive Learning: The Casewriting Method as an Entire Semester Course for Higher Education

A complete listing of monographs is available at <http://cid.unomaha.edu/~nasa>; select UNO Aviation Monograph Series.

### To Obtain Monographs

Complete this form and include a check or purchase order made payable to the Aviation Institute. Orders within the U.S. are \$7.50 (U.S.) per monograph, and international orders are \$10.00 (U.S.) to cover the costs of printing, shipping, and handling. Allow 4-6 weeks for delivery. Please forward this request to: *Aviation Institute, University of Nebraska at Omaha, 6001 Dodge Street, Omaha, NE 68182-0406*. Phone: 402-554-3424 or 1-800-3 FLY UNO; Fax: 402-554-3781; E-mail: [nasa@unomaha.edu](mailto:nasa@unomaha.edu)

Name \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

City, St., Zip \_\_\_\_\_

Country \_\_\_\_\_

Phone \_\_\_\_\_ E-mail \_\_\_\_\_

Quantity	Monograph #	Unit Cost	Total Cost
			\$
			\$
			\$
TOTAL ENCLOSED			\$

*This series is co-sponsored by the NASA Nebraska Space Grant Consortium*



## ATRG Networking Committee

Prof. Tae H. Oum (Chair-person)  
University of British Columbia  
Vancouver, Canada

Prof. John Brander  
University of New Brunswick  
Fredericton, N.B., Canada

Prof. Kenneth Button  
George Mason University  
Fairfax, Virginia, USA

Prof. Martin Dresner  
University of Maryland  
College Park, Maryland, USA

Prof. Christopher Findlay  
University of Adelaide  
Adelaide, Australia

Prof. Mark Hansen  
University of Southern California at Berkeley  
Berkeley, California, USA

Mr. Stephen Hunter  
Bureau of Transportation  
Canberra, Australia

Dr. Juergen Mueller  
Fachhochschule fuer Wirtschaft Berlin  
Berlin, Deutschland

Prof. Eiji Shiomi  
Chuo University  
Hachioji City, Tokyo, Japan

Prof. John Black  
University of New South Wales  
Sydney, Australia

Prof. Joseph Berechman  
Tel Aviv University  
Ramat Aviv, Israel

Prof. Anthony Chin  
National University of Singapore  
Kent Ridge, Singapore

Prof. Jaap de Wit  
Dept. of Civil Aviation  
The Hague, Netherlands

Prof. David W. Gillen  
Wilfrid Laurier University  
Waterloo, Ontario, Canada

Prof. Paul Hooper  
University of Sydney  
Sydney, Australia

Prof. Steven A. Morrison  
Northeastern University  
Boston, Massachusetts, USA

Dr. Dong-Chun Shin  
Civil Aviation Bureau  
Korea

Dr. Michael W. Tretheway  
VISTA c/o YVR Marketing  
Richmond, B.C., Canada

## ABOUT THE EDITORS

Dr. Aisling Reynolds-Feighan received her B.A. and M.A. in Economics from University College Dublin, Ireland, and her Ph.D. from the University of Illinois in 1989 in the field of Regional Science. She has been a College Lecturer at University College Dublin in Economics since 1990, where she teaches Transport Economics and Regional Science courses. Her main research interests are in air and road transport, with particular emphasis on the links between transport and regional economic development. She has published several studies examining the impacts of airline deregulation in the US and Europe including *The Effects of Deregulation on U.S. Air Networks* (Springer-Verlag, 1992).

Dr. Brent D. Bowen is Director and Professor, Aviation Institute, University of Nebraska at Omaha. He has been appointed as a Graduate Faculty of the University of Nebraska System-wide Graduate College. Bowen attained his Doctorate in Higher Education and Aviation from Oklahoma State University and a Master of Business Administration degree from Oklahoma City University. His Federal Aviation Administration certifications include Airline Transport Pilot, Certified Flight Instructor, Advanced-Instrument Ground Instructor, Aviation Safety Counselor, and Aerospace Education Counselor. Dr. Bowen's research interests focus on aviation applications of public productivity enhancement and marketing in the areas of service quality evaluation, forecasting, and student recruitment in collegiate aviation programs. He is also well published in areas related to effective teaching. His professional affiliations include the University Aviation Association, Council on Aviation Accreditation, World Aerospace Education Organization, International Air Transportation Research Group, Aerospace Education Association, Alpha Eta Rho International Aviation Fraternity, and the Nebraska Academy of Sciences. He also serves as program director and principal investigator of the National Aeronautics and Space Administration funded Nebraska Space Grant and EPSCoR Programs.



### ***ATRG President's Foreword***

The **Air Transport Research Group** of the WCTR Society was formally launched as a special interest group at the 7<sup>th</sup> Triennial WCTR in Sydney, Australia in 1995. Since then, our membership base has expanded rapidly, and now includes over 400 active transportation researchers, policy-makers, industry executives, major corporations and research institutes from 28 countries. Our broad membership base and its strong enthusiasm have pushed the group forward, to continuously initiate new events and projects that benefit the aviation industry and research communities worldwide.

It became a tradition that the ATRG would hold an international conference at least once a year. As you know, the 1997 conference was held in Vancouver, Canada. Over 90 papers, panel discussions and invited speeches were presented. In 1998, the ATRG organized a consecutive stream of 14 aviation sessions at the 8<sup>th</sup> Triennial WCTR Conference (July 12-17: Antwerp). Again, on 19-21 July, 1998, the ATRG Symposium was organized and executed every successfully by Dr. Aisling Reynolds-Feighan of the University College of Dublin.

As in the past, the Aviation Institute at the University of Nebraska at Omaha (Dr. Brent Bowen, Director of the Institute) has kindly agreed to publish the Proceedings of the 1998 ATRG Dublin Symposium (being co-edited by Dr. Aisling Reynolds-Feighan and Professor Brent Bowen), and the Proceedings of the 1998 WCTR-ATRG Conference (being co-edited by Professors Tae H. Oum and Brent Bowen). On behalf of the ATRG members, I would like to express my sincere appreciation to Professor Brent Bowen and to the staff at the Aviation Institute of UNO for their efforts in publishing these ATRG proceedings. Also, I would like to thank and congratulate all the authors of the papers, for their fine contribution to the conferences and the Proceedings.

Finally, I would like to draw your attention to the ATRG newsletter and the ATRG website ([www.commerce.ubc.ca/atrg/](http://www.commerce.ubc.ca/atrg/)) which will keep you informed of the ATRG operations and forthcoming events. On behalf of the ATRG Networking Committee, I would also appreciate it very much if you would encourage others in the field, to sign up for ATRG membership. Thank you for your attention.

**Tae H. Oum**  
**President, ATRG**

ATRG c/o Prof. Tae H. Oum  
Faculty of Commerce and Business Administration,  
University of British Columbia, 2053 Main Mall  
Vancouver, B.C., V6T 1Z2  
Canada  
E-mail: [atrg@commerce.ubc.ca](mailto:atrg@commerce.ubc.ca)



## OPENING ADDRESS AT THE 1998 ATRG DUBLIN SYMPOSIUM

Tae H. Oum  
President,  
Air Transport Research Group

Dr. Cosgrove, Distinguished Guests, Ladies and Gentlemen,

As the President of the Air Transport Research Group, it gives me great pleasure to welcome all of you to the 1998 symposium. The ATRG was originally founded in Sydney in 1995 as a special interest group of the WCTR Society. While the purposes of the ATRG continue to evolve, may I attempt to summarize them in several categories here tonight:

- 1) To provide independent forum for discussion on all issues in aviation.
- 2) To promote interaction among aviation researchers, policy- makers and managers/ executives.
- 3) To encourage the collaborative research of international scope such as: hub- and-spoke systems involving cross-boundary airline networks; bilateral/ multilateral liberalization; performance evaluations of carriers and airports.
- 4) To cultivate the exchange of ideas, data, and research results among researchers around the world.

To begin to accomplish these objectives, the ATRG held its first conference in July, 1997, in Vancouver, Canada, where more than 90 papers and panel presentations were made. This year, we organized 14 consecutive aviation/ airport sessions (54 aviation papers) at the 8th WCTR in Antwerp, Belgium. Today and tomorrow, this symposium in Dublin will provide yet another important forum for us to engage in lively discussions on some critical issues regarding airlines and airports. This symposium is particularly timely because we anticipate that major changes will be forthcoming in the European aviation industry.

Ladies and Gentlemen, I am also pleased to announce that our colleagues in Hong Kong, represented by Professors Anmin and Yimin Zhang, and Jong Park, will be hosting the next ATRG conference some time in June 1999. Given the young age of the ATRG (only a 3- year old baby), you will all agree with me that the ATRG has made remarkable progress in achieving some of its goals. Membership wise, we are approaching some 400 individual and organizational members. Every year, the quantity and quality of our papers and debates, have grown and improved.

For example, at the WCTR in Antwerp, held last week, our aviation papers won 3 out of 10 awards, including:

Best Paper Award from the WCTR Society,

Special Young Prize Award from the Antwerp High Council of Diamonds,

Be- Ne- Lux Transport Economics Award.

These papers were chosen out of nearly 900 papers that were presented. Ladies and Gentlemen, let me do a small commercial if I may: we are a Winning Group! If you are not already a member, please sign up for membership TODAY.

My sixth sense tells me that starting this year, the ATRG needs to embark on several group projects of international scope. For this, I will be seeking your opinions during the ATRG Business meeting. TODAY and TOMORROW, I look forward to stimulate discussions on some important matters involving the European and world aviation industries.

Before closing, I would like to express our deep appreciation to Dr. Art Cosgrove, President of UCD, for the marvelous support, received from his institution. I would also like to formally thank Dr. Aisling Reynolds-Feighan for her near solo effort to prepare and execute this symposium. My thanks also goes to Dr. Reynolds-Feighan's colleagues, students and other university staff members for their help and support.

With these remarks, I am now pleased to declare the opening of the 1998 ATRG Dublin Symposium: European Air Transport in the New Millennium.

Thank you very much.

**AIR TRANSPORT RESEARCH GROUP OF WCTR**

**AIR TRANSPORT RESEARCH SYMPOSIUM**

**"AIR TRANSPORT IN THE NEW MILLENNIUM:  
OPPORTUNITIES IN COMPETITIVE MARKETS"**

**JULY 20-21, 1998  
ENGINEERING BUILDING, UNIVERSITY COLLEGE,  
DUBLIN 4, IRELAND**

**PLENARY SESSION:  
"IRISH AIR TRANSPORT POLICY IN THE NEW -/  
MILLENNIUM"**

**JOHN LUMSDEN  
ASSISTANT SECRETARY-GENERAL AND  
DIRECTOR GENERAL OF CIVIL AVIATION  
DEPARTMENT OF PUBLIC ENTERPRISE  
DUBLIN 2**

JMT

## IRISH AIR TRANSPORT POLICY IN THE NEW MILLENNIUM

### SECTORAL CONTEXT

In keeping with the long run global trend in international trade from protectionism to free trade, civil aviation has in recent years been moving from a structure characterised by:

- exchange of traffic between national governments as elements of national sovereignty;
- approval of air fares nominally reserved to national governments but in reality delegated to fare-fixing conferences of nationally-owned "flag-carrier" airlines;
- airports as State-owned public utilities; and
- provision of air navigation services by national governmental authorities;

to a structure characterised by:

- liberal "single market" competition principles within major trading blocs such as the European Union and the USA and moves towards "common aviation areas" on a multilateral basis between those trading blocs;
- growth in privately owned airlines and in the privatisation of the former "flag-carrier" national airlines, combined with an increasing tendency for regional and global strategic alliances between airlines;
- the gradual evolution of airports into more commercial entities and the privatisation of airports in some countries; and similarly
- a move towards corporatisation and privatisation of national air navigation services.

The driving force behind this process has been the realisation on the part of governments that the former structures militated against cost effective commercial practices and thus against economic growth and prosperity generally.

The Department of Public Enterprise has played an active part in the EU arena in the change from protectionism to competition. The benefits have been apparent in the strong growth of Irish aviation and downward pressure on air

fares in our main markets of the UK, the rest of Europe and the USA. Aviation liberalisation has been one of the main contributors to the success of our tourism sector over the last decade.

The following paragraphs are an introduction to sectoral issues which are addressed later in this paper in the context of objectives, strategies etc.

### **AIR SAFETY**

The international emphasis on cost efficiency in the drive towards lower air fares is one of the principal features of the new competitive aviation environment. Care needs to be taken that cost efficiency is not achieved at the expense of safety and that the traditionally very high standards of safety in Irish and international civil aviation are maintained. The emphasis on cost efficiency must be matched by constant renewal of the emphasis on safety on the part of the operators (aircraft and component manufactures, airlines, airports and air traffic control agencies) and the overseeing national and international safety regulatory authorities.

### **AIRSPACE MANAGEMENT**

The European institutional arrangements in air traffic management are traditionally based on an excessive emphasis on national sovereignty and the independence of national air traffic management agencies. The new Eurocontrol Convention signed by Ireland and other European States in June, 1997, when brought into force, will provide for a stronger Eurocontrol Agency, with the emphasis on integrated international airspace management.

Globalisation in systems and management through the development of new satellite based technologies is the major medium term challenge facing the European airspace management system. These developments taken in context of Ireland's unique geographical position at the interface between the North Atlantic and Europe require a proactive response to the opportunities and challenges presented.

### **THE ENVIRONMENT**

There is an increasing emphasis in international fora on the impact of aviation on the environment, in terms of noise and air pollution. Possible measures to lessen these negative effects are being discussed including taxation of aviation fuel. Agreement on such measures will involve reconciling policies on protecting the environment with policies aimed at maximising the growth of aviation.

### **TRANSATLANTIC SERVICES**

As proposed in the 1997 Statement of Strategy, the Shannon stop requirement (whereby airlines that wish to operate direct transatlantic services to Dublin must operate an equivalent number of direct services to Shannon in any twelve month period) has been reviewed and it has been reaffirmed as Government policy. The requirement owes its existence to the desire of successive Governments to favour balanced regional development. The commercial success of Shannon airport is seen as a very important driver of the economy of the mid West region. In that regard, the decision of Continental Airlines to inaugurate year round scheduled services to both Shannon and Dublin from June, 1998 is particularly welcome.

### **AIRPORTS**

The threatened ending of duty-free in mid 1999 is a major strategic issue which would severely impact on the finances of both the State and the regional airports, thereby putting upward pressure on airport charges to airlines and hence on air fares.

Major programmes of capital expenditure, funded by Aer Rianta, are underway at the three State airports to cope with increasing passenger and freight throughput.

A package of Exchequer financial support for infrastructural improvements to be implemented in 1998 has also been put in place by the Government for the regional airports. This is in addition to the Exchequer marketing assistance programme for those airports which runs to end 1999. In order to improve access to and from those airports, the Department has in place a scheme of Exchequer subvented public service obligation air services connecting them with Dublin airport.



## **SECTORAL OBJECTIVES**

The Department has the following objectives for the air transport sector:

- To ensure that the standards, safety and security of aviation continue to inspire confidence in the use of Irish aerospace and technical infrastructure;
- To facilitate and encourage a wide range of reliable, regular and competitive commercial air services for Irish tourism, trade and industry;
- To seek to maintain at least one domestically based and financially viable airline of sufficient scale to provide air services between Ireland and all our main export markets on a year round basis; and
- To ensure that Irish airports are cost competitive and have appropriate infrastructure to meet the current and prospective needs of the international airline industry.

## **SECTORAL STRATEGIES AND OUTPUTS**

In the case of aviation, the individual strategies and outputs often contribute to achieving a number of sectoral objectives. The key strategies and related outputs to be pursued are based on maximising growth of Irish aviation in the current economic climate and positioning the Irish aviation sector to cope with the next downturn in international aviation in the longer term.

The Department seeks to ensure the achievement of objectives in air transport in a number of ways.

### *Development of Air Services by:*

- encouraging the development of new air services to and from Ireland through the conclusion of liberal bilateral air services agreements with non-EU states
- implementing the scheme of public service obligation air services connecting Dublin airport with the regional airports.

### *Proposing a more clearly defined Airports Regulatory Framework*

- in response to the change in legal status of Aer Rianta coupled with emerging regulatory legislation at European level on airport ground handling services and airport charges.

*Continuing the campaign against the decision to end intra-EU Duty free sales as set out in the Programme for Government*

- by seeking agreement between all EU Governments and the European Commission that abolition of duty free is not in the interests of the European aviation sector and European consumer generally.

*Responding to technological developments in airspace management:*

- by developing, in conjunction with the Irish Aviation Authority, a strategy for a coherent and proactive response to the emerging satellite based air traffic management system.

*Creation of more effective inter-governmental agencies for dealing with key issues:*

- by taking a proactive part in European efforts to create more effective inter-governmental agencies for the management of airspace and regulation of air safety.

## **PERFORMANCE INDICATORS**

### **Sectoral**

- Continued safe operation of Irish aviation, as evidenced by the low level of accidents and incidents relative to the scale of air operations.
- Continued safe, orderly and expeditious flow of traffic in and through Irish controlled airspace, at lowest possible cost.
- Growth in the range of air services and in passenger and freight traffic to and from Ireland.
- Increase in the number and scale of Irish airlines, based on commercially sustainable growth.
- Removal of capacity constraints in infrastructure at Irish international airports.
- Improvement in the competitive positions of Irish international airports as far as airport charges are concerned.

### **Departmental**

- further bilateral air service agreements with non-EU States to be concluded.
- effective implementation of the scheme of public service obligation air services.
- proposals for a more clearly defined airports regulatory framework, including a formal bench-marking process for the airports, to be finalised in 1998; necessary measures arising therefrom to be implemented in 1999.
- completion in 1998 of proposals for responding to the future satellite based air traffic management technologies and follow through in subsequent years of any necessary policy initiatives arising.
- a restructured Eurocontrol agency operating under the new Eurocontrol Convention, by the end of 1999.
- political agreement on a pan-European level on the form, structure and functions of a new European air safety regulatory body, by the end of 1999.

### **SHAREHOLDER ISSUES**

#### **Aer Lingus**

Aer Lingus has emerged from its financial crisis of the early 1990s. The position of the Government and the European Commission is that further State aid for Aer Lingus is ruled out. The strongest possible commercial focus within Aer Lingus is therefore essential. While progress has been made, unless the commercial imperative continues to be accepted throughout the Aer Lingus Group, there is a risk that the Group will be unable to control its cost base sufficiently and adapt its commercial strategies so as to withstand increasing competitive pressures, particularly when exacerbated by the next cyclical downturn in the aviation industry. The putting in place in late 1997 within Aer Lingus of an agreed partnership process to achieve further significant cost savings is, therefore, of great importance.

The Irish Aviation Policy document published in 1994 stated that the Government would encourage Aer Lingus to develop appropriate strategic alliance and that all proposals would be considered on their merits. The 1997 Statement of Strategy mandated the Board of Aer Lingus to explore the possibilities of entering into a major strategic alliance, with or without the

transfer of equity, and to submit proposals to the shareholder. The Board's response is awaited.

#### **Shareholder Mandate**

- Continue to operate in accordance with strict commercial criteria;
- Ensure that results and shareholder value benchmark favourably with comparable competing private sector airlines within a two or four year timescale; and
- Submit proposals to the shareholder in relation to the possibilities of entering into a major strategic alliance, with or without the transfer of equity.

#### **Aer Rianta**

Aer Rianta's current legal status as an agent of the Minister is an anachronism. It needs to be established as a normal commercial State company. This involves transferring the three State airports from the Minister's ownership to that of Aer Rianta. The recently enacted Aer Navigation and Transport Act, 1998 makes the necessary statutory arrangements for these changes and will be implemented from 1 January 1999.

The threatened ending of duty-free in mid 1999 is a major strategic issue which would severely impact on the finances of Aer Rianta, thereby putting upward pressure on airport charges to airlines and hence on air fares.

#### **Shareholder Mandate**

- Provide the necessary infrastructure and services to Dublin, Shannon and Cork airports, at the lowest possible cost, consistent with safety and commercial operations;
- Provide a financial return to the shareholder consistent with the foregoing requirement;
- Promote the development of traffic at Dublin, Shannon and Cork airports; and
- Exploit new business opportunities, provided they are organically linked to the company's core business and do not detract from core responsibilities.

## **Irish Aviation Authority**

### **Údarás Eitlíochta na hÉireann**

The Irish Aviation Authority since its inception in 1993 has successfully managed its transition from within the Department to a commercial State company.

The continuing growth in air traffic and the arrival of satellite based technologies designed to make more efficient and safer use of air space are the major challenges facing the Authority in the future.

### **Shareholder Mandate**

- Provide air navigation and safety regulatory services which are cost effective, correspond to best international practice, and continue to inspire confidence in the use of Irish airspace and technical infrastructure;
- Discharge its statutory obligation to be self-financing; and
- Exploit new business opportunities, provided they are organically linked to the Authority's core functions and do not detract from core responsibilities.

Plenary Session:  
Irish Air Transport Policy in the New Millennium

John Burke

Chief Executive, Aer Rianta, Irish Airports

Thank you Chairman. Good morning Ladies and Gentlemen. I'm delighted that this seminar is taking place and I'm very pleased to be invited to participate in it. Aer Rianta is responsible for the management and operation of the three state airports in Ireland, Dublin, Shannon and Cork airports. As Dr Fitzgerald, (the session Chairman) mentioned we have extensive interests overseas in the duty free business and more recently in airport ownership and we own the Great Southern Hotels chain in Ireland. The Minister for Public Enterprise, Mary O'Rourke and her Department sets the policy for Aer Rianta and the policy as it applies to Aer Rianta in the document that John referred to, *Strategic Management Initiative*, requires us to provide the necessary infrastructure and services at the three state airports at the lowest possible cost, consistent with safe commercial operations, to provide a financial return to the shareholder which is consistent with the foregoing requirement and to develop traffic at the three state airports and to exploit new business opportunities, provided they are organically linked to the company's core business and do not detract from core responsibilities (core responsibilities being the management of Dublin, Cork and Shannon airports). The aspects of the policy that I will deal with this morning are the provision of the necessary infrastructure and in that context, the importance of long-term planning, which has been adopted up until now. I will also briefly cover charges and the development of traffic at the three airports and I will make some references if I have time, to overseas business opportunities and funding issues. I'll start with the planning.

Ireland was very early into aviation and as Dr Fitzgerald mentioned, the terminal at Dublin Airport built and designed by his brother was built in 1937. Shannon was the gateway to the west, to the US in the very early days and I think we probably owe it to that that the planning in Ireland as far as aviation was concerned and the airport was very long term in its nature. For example in Dublin airport (and I will talk mainly about Dublin airport for the purpose of this paper), the lands for two parallel runways, each over three thousand metres long were acquired in the sixties and seventies at a time when traffic at Dublin airport was less than two

million passengers. And these two runways, when built, would provide capacity for passengers in excess of forty million so that was fairly long range. The first of these runways were completed in 1989 and the second one will be built within the next ten years. Throughout this period which is a period of over thirty years, approaches to the existing and proposed runways were kept relatively free from development and as a result there are no constraints at present on future developments in Dublin airport - No restrictions on aircraft movements, no noise budgets or curfews or no noise or cost penalties. Now this can be contrasted with many other airports in Europe and further afield, where there are plenty of examples of tightly constrained airport sites and operational restrictions and we need to be as far sighted today as our predecessors were thirty years ago. And when I say we, I mean not just Aer Rianta, I also include the Department of Public Enterprise, the IAA and the local planning authorities. It's also most important that plans for future growth and development be formulated in consultation with the local communities. By the end of this year we will have completed the master plan for Dublin airport for the next twenty years and the key outstanding issues still to be addressed in that plan will be the exact commencement date for the construction of the second parallel runway; the future of the existing cross-runway and the next phase of terminal development to cater for passengers in excess of twenty million passengers. This year we will have over eleven million passengers at Dublin airport. You can look at the provision of infrastructural capacity at airports under three headings. One would be the airfield capacity including the runways, taxi ways and aprons. Second would be the terminal capacity which includes check in desks, gate lounges and baggage holds and the third would be surface access to the airports including car parks. The existing airfield capacity is more than adequate for present and future needs. Our only worry in this regard would be a bad planning position which would restrict further expansion. We would also be concerned about the development of housing in approaches to the runways which could cause problems in the future. With regard to terminal capacity, we are experiencing some congestion at check-in and in the baggage hold at peak periods. We don't have a problem on the airside. We have a new Pier C, an expanded Pier A, an expanded Terminal West, new boarding gates in the old central terminal building. The building that Dr Fitzgerald referred to, is back now in operation. Construction has started on Pier C phase two, which will be completed by the end of 1999 and work has also commenced on expanding the terminal to in effect, double it in size. If you go through Dublin airport you will see a big hole in the ground which is the beginning of that project. The fourth, the construction of a fourth pier is also proposed. And

this will bring the terminal capacity levels to in excess of twenty million passengers by the end of the year 2000. We have followed the original planning concept which provided for phased development of the existing site, based on a single terminal with piers and it's interesting if you look at the 1968 annual report, for Aer Rianta. There is a scheme in that which more or less reflects what we are about to do in the next few years and we still believe that the single terminal concept is the ideal model for airports because there's no confusion with different terminals. No problems with transferring from one terminal to another, either for passengers or baggage. It's excellent for hub development and economically efficient to operate and of course, lower cost to the users. Anyone who has had to transfer from terminal one to terminal four at Heathrow will know what I mean. Single terminal airports such as Schipol, Dusseldorf or Copenhagen are much easier than Heathrow or JFK, examples of how not to do it, from our point of view. There have been a number of suggestions recently and this is why I'm mentioning the single terminal idea, regarding the concept of competing terminals and it is frequently referred to in the media. From our experience, where second terminals are built, they are built exclusively for capacity reasons and even where private or external funding is used, it's just that the airport authority doesn't have the funds itself and again it's not for competition. There are some models that are referred to, such as Brussels and Toronto and even Birmingham. But these models have either been reversed or are in the process of being reversed. I don't know how terminals could, in any practical way, compete. Ignoring the operational difficulties, at the very least it would require excess capacity in both terminals, another duplication which could only result in higher costs rather than lower costs to the user. So from a policy point of view, it's Aer Rianta's intention to continue to develop terminal facilities at Dublin to the maximum extent as a single terminal facility. Much of what you would say about single terminals also applies to single airports in a city. Tom Haughey in a paper given in another session at this symposium has already addressed the general issue of competition. I don't intend to go further into this aspect. I do believe however the airport should be subject to regulation and I welcome John Lumsden's remarks about setting up a formal regulatory framework. Probably the most important issue facing Dublin airport and indeed Shannon airport is surface access and this will be a very important aspect for us in the next planning phase. Even if we have the capacity on the airfield and in the terminal for over twenty million passengers, we still have to get them into the airport and it's very important in this context that the motorway, the M1 North proceeds as quickly as possible because this will take two thirds of the road traffic away from the airport. This traffic is going to Belfast and



Swords and other places north of Dublin airport. Car parking is a major issue. We already have eighteen thousand car park spaces at Dublin airport. The equivalent of eighty five acres, covered by cars and that's growing. The car traffic is growing quicker than the passenger traffic which is already growing in double digit figures. We probably contribute to this growth ourselves because our car parking charges in the long term car park are just IR£12 a week or less than IR£1.72 per day and we have to look at that in managing the demand for car parking spaces. We would also welcome the development of public transport to Dublin airport including the LUAS (the light rail system) and of course bus and coach services and in the longer term, a direct rail link. We have recently written to the Minister asking her to give priority to the LUAS line from Broadstone to the airport. With regard to traffic development, we've invested very heavily in traffic development at all three airports in the past five years and in the light of the rapid growth in the economy, it's likely that there would have been growth at the airports anyway. Particularly at Dublin airport but with the kind of growth we have at Dublin airport we no longer see the need for a growth incentive scheme and we will be discontinuing any new growth incentive scheme in Dublin airport from the first of January next year. We will have growth discount schemes at Shannon and Cork airports. We support regional development and we welcome the Department's recent review of the transatlantic policy and it's reaffirmation of Shannon's status as a designated gateway. As a measure of our confidence in the future growth of Shannon we are about to embark on the construction of a modern unified terminal at Shannon airport and Cork airport will also benefit from a widening of the runway and the runway overlay and extensions to the terminal and apron and car parks and a new freight terminal. Cork is also an important regional gateway and has achieved high growth over the past decade. It is expected that this growth momentum will be contained and the corporate policies to support the continued rapid growth of Cork airport also. With regard to airport charges, there's a lot of controversy about that as John already mentioned. But airport charges only account for 16% of Aer Rianta's revenue which by any standards is extremely low. We're involved in the business of looking at airports overseas from the point of view of investing and we do not come across any airports where the aviation revenue is less than say even 30% or, it's more likely closer to 40-50%; but in Aer Rianta it's just 16% and we've been able to do that by freezing our charges since 1987 and of course, subsidising it by our revenue from duty free. Duty free sales which is now under threat and this has a particular impact on Aer Rianta airports because we're very good at duty free and most of our traffic is intra-EU, so in that context, we will be looking at the charges. We won't have a knee jerk

reaction to just solving our problems by looking for an increase in charges but the charges are alarmingly low and even if there wasn't a threat from duty free, I think that the charges would need to be looked at.

Lastly I'll just mention that we have significant opportunities overseas. We have recently invested in the ownership of Birmingham and Dusseldorf and all of this has been funded by our activities overseas. It hasn't come from the home airports and we see it as important to balance these airport type investments with duty free. Airport investments are capital intensive, duty free activities have relatively moderate capital requirements and provide high cash flow. Just on the legislation, we now own the airports, we're no longer the agent for the Minister, we don't have significant cash reserves. We haven't been able to build up cash reserves in the past. We've a major capital programme at the three airports. Three hundred million pounds and the only way we can fund that is from borrowings and future earnings. We have also these many opportunities overseas and particularly from the privatisation of airports and we're currently looking at ways of funding those opportunities within our wholly owned subsidiary Aer Rianta International. Thank you.

---

CONF

Plenary Session:  
Irish Air Transport Policy in the New Millennium

Garry Cullen  
Chief Operating Officer, Aer Lingus plc, Ireland

Thank you Chairman and good morning ladies and gentlemen. Dr Fitzgerald referred to his links with Aer Lingus and I had the pleasure when I joined the planning department to be occupying the desk that was previously occupied by Doctor Fitzgerald which was an honour. I'm also delighted to see my former boss, Antoin Daltun is in the audience for today. It is my pleasure to have the opportunity to give a view on Ireland's developing air transport policy from the perspective of Aer Lingus, a medium sized state owned airline. I'm particularly pleased to be asked to participate at such an auspicious conference as this one is because a few years ago you would have been forgiven for striking Aer Lingus executives off your invitation list. My company was in serious trouble in 1990, early 1990's and in fact in 1993, we lost IR£191 million and had the year end debt of IR£335 million which is some achievement for a company the size of Aer Lingus but happily we've come a long way from the situation we actually faced then. There were a number of reasons we found ourselves in that position. The core air transport business was loss making and it was struggling with the adjustment to the start up era of increased liberalisation and deregulation and the industry itself was experiencing a general down turn. Added to that our investment in a number of ancillary businesses also suffered. In fact, what was meant to be counter-cyclical investments actually exacerbated the swings in our business cycle and then of course we faced the immediate impact of the Gulf War which almost stopped US leisure travel to Ireland dead. Added to that just to complete the tail of sorrow, we had a major investment in Guinness Peat Aviation, GPA, which collapsed at that time. So literally, our company's back was to the wall but with the support of the share holder, the Irish Government and in consultation with our staff who understood that tough action was called for in the long term interest of the company and themselves, we devised a recovery strategy followed by a long term strategy for profitable growth. But first obviously the priority was survival. A major cost reduction programme was launched as one of four steps necessary to bring the airline back into profitability. What we did first was to put a cost saving programme in place and we managed to save about IR£50

million and reduced the work force by twelve hundred. We divested ourselves of the non-core businesses. In fact we started the process then and we have almost completed the process of divesting ourselves of non-core activities and the government came to our support in two very particular ways. Firstly we received a cash injection of a IR£175 million . The company was at that time grossly under capitalised. In addition, a regularity change was agreed between the Irish and US governments which enabled carriers on the North Atlantic to offer services to both Shannon and Dublin airports. Previous to that Shannon was the designated transatlantic airport for Ireland. So assisted by a major restructuring programme and by the boom in the Irish economy in recent years and also recovery in air transport generally, Aer Lingus has performed well since 1993. We've had three years of growing profits and this year is also a good year. But we are all very clear and very conscious of the fact that we need to do a lot better in order to sustain continued prosperity and also to be, let's face it, to be adequately prepared for the inevitable down turn which will come in the industry. The company I suppose is one that operated reasonably well in a protected regulatory environment. It operated very well I might say. We made steady profits for many years but we were clearly ill prepared for the extent and the depth of change which we faced and the reason I'm giving you that brief history is by way of background and how we view working under Irish aviation policy now and in the immediate future and looking at this I suppose from the perspective of a long serving and at times long suffering airline executive who's experience of managing in both eras. But I'm very clear in which environment I prefer to work in and do business in. Now in Aer Lingus there's a certain vibrancy and a fast growing commercial ethos in the company. There's a belief in our business direction and in our product and in our service. The transformation that is currently taking place is due to the, in the first instance the continued commitment of our staff but we're also greatly benefiting from the open aviation policy of this country and the emerging role that our owners see for Aer Lingus. The state relationship with Aer Lingus impacts in three ways. It acts as a policy maker for our industry; it is our shareholder and the state owns ninety five percent of the shares in Aer Lingus and traditionally it was the regulator of the airline business. Now the European Commission looks after the internal market of the EU but the government still plays a major role for instance in Ireland-US bilateral matters. Balancing these three roles can be tricky and I know the Department is continually reviewing how it can best exercise these three vital functions but it is government policy to facilitate and encourage a wide range of regular and competitive air services in and out of Ireland and additionally, and this is of particular interest to Aer Lingus,

it seeks to maintain at least one domestically based and financially viable airline of sufficient scale to provide air services between Ireland and all our main export markets on a year round basis. Thereby spelling out it's encouragement for both an open, competitive environment but also the desire to have at least one domestic player providing a comprehensive service to all sectors. We see Aer Lingus through its positioning as a full service airline with its own network covering Europe and the United States, across all markets critical to Ireland. We seek to fulfil this role as we develop our business strategy going forward and we do this also having regard to the specific mandate that the government sets for Aer Lingus. The mandate covers the three areas, and requires that we operate within strict commercial criteria, that we ensure that how we run our business benchmarks favourably with best in business and, we also have a mandate to produce, or submit proposals to the shareholder evaluating the possibilities of Aer Lingus entering into any major strategic alliance, with or without a transfer of equity. Accordingly, as we develop our own business and our own strategy going forward, there are three distinct but inter related strands. Firstly, the determination of our market positioning. That was very important. We needed to take stock of it in the early nineties and say what does Aer Lingus stand for and what future has it got in the market, particularly in a market that's changing and is changing so quickly. In the current environment obviously, some airlines are focusing on low cost, no frills operations. Others are facing the future as a full service value added carrier, with a strong customer service ethos. Allied to this positioning is the likely direction, either to be a stand alone niche operation or to be a global player. We have nailed our colours to the full service mast, believing that travel experience for business and leisure customers alike, can still revolve around quality of service and good value. I firmly believe and we are increasingly proving that there is a market for this product, delivered well and delivered consistently. Accordingly what we've done over the last couple of years is to invest very heavily in our brand. We've launched a new corporate identity, we have refocused our brand values, bringing back emphasis on core attributes of professionalism, intuition and intimacy. We face major IT investments in the area of revenue and yield management, in the whole area of ticketless travel, automated boarding, developing a new customer database, so there's major, heavy investment going on in the IT side of the company now. We've introduced new aircraft to the fleet. We've recently taken delivery of eight A321s for our London routes and will shortly be bringing eight A320s in for our mainland European operations. We're also changing our commuter operation to all-jet services and we are experiencing significant competitive success on the key UK routes which

again is showing there are two markets there. There's a market for the lowest price, no frills. There's also a market for a carrier that is selling the value message. But our biggest transformation has been on the North Atlantic and we've really enjoyed very good success on the North Atlantic. We've grown from three A330s, to seven this winter. We've doubled the number of gateways, adding Chicago and Newark to JFK and to Boston and we're looking at additional gateway opportunities. In fact on the North Atlantic over three years we've actually increased our peak schedule by fifty percent and the off peak winter schedule by three hundred percent and passenger numbers have almost doubled in this period, so it really has been a period of significant growth and also a growth in profits I'm happy to say. What we're doing is basically adding up the one thing that is at the core of our thinking and this is the message that we're getting out to our customers or potential customers, that what we are offering is value. And despite the high profile of the low price, no frills proposition, I believe there's still much mileage in the value equation. Now we're achieving the improvements we made to date and particularly coming back to 1993, none of this would have been possible without the full involvement and commitment of the staff in Aer Lingus and it is the same level of staff commitment, it's with that level of staff commitment that we're pursuing the second strand of our strategy which is to ensure that we run our business in the most efficient manner possible and that we benchmark favourably with any competitor. So what we've done is we've launched a partnership programme with our trade unions and staff which is committed to reviewing fundamentally how we do our business right across the company and seeking to identify and implement the maximum efficiencies possible. You can take it for granted in a sixty year old company that there are many work practices and organisational structures in place that maybe were appropriate for the 1960s, but are not appropriate for the 1990s. Now we made progress as I say back in '93 but we have set ourselves a target now of taking an additional fifty million pounds in costs out of the company over the next three to four years. It's imperative that we deliver that and we obviously will be looking also to get value from our suppliers and I was listening with keen interest to what John was saying about charges in Dublin Airport and also about what he was thinking of doing with incentive schemes. But we'll have plenty of time to discuss that at another date. But this whole trend towards global consolidation. This is the third strand if you like to our strategy. Our owner obviously, and John Lumsden has made reference to it, has mandated us to examine the opportunities open to Aer Lingus in terms of global alliances and partnership opportunities. Personally I believe that we need to join a major strategic alliance grouping in order to secure and enhance the

competitive position of Aer Lingus going forward. Currently we have a number of route specific tactical alliances but we don't have an exclusive agreement with any major carrier or group of carriers. I think membership of such a grouping brings with it, it obviously brings with it a joint venture approach to network development, facilities, operations, co-ordinating capacity and service. And I think also and obviously we would need to manage this with extreme care because we are a small carrier but what we would be seeking to do is to enjoy the benefits of a global brand while protecting our own brand and if we achieve that and do it right I think it will ensure the future success of Aer Lingus, particularly in the North American market, it's very important. It also, linking back it enables us to comprehensively fulfil the role of a carrier best suited to meet the diverse needs of Irish tourism and business. Albeit not entirely with our own resources but through being able to make a global alliance offering. To balance all these change factors and all the issues that we're trying to handle in Aer Lingus at the moment, we've launched both for the external audience and internally what we call a programme for a better airline. In essence this is a long term umbrella communication programme covering all aspects of the changes and the improvements that we're seeking to make. Looking to the future of the business in general, the changes that took place in the last ten years, certainly were more rapid and more profound than in the previous thirty but I think we are, what we have experienced may eventually when we look back be seen as a small change compared with what's going to happen over the next ten years or even five years. I think it is very likely that our industry is going to change fundamentally particularly within Europe. I mean the completion of the ongoing regulatory process and the onset of open skies obviously is going to drive further change through. I mean things have already changed beyond recognition among many of the European carriers and there are winners and losers among the older airlines and some will successfully restructure themselves. Some are emerging badly bruised and uncertain over their future and some will go out of business. What strategy and what direction is decided for Aer Lingus, whatever it is, we will approach it from a position of confidence. We face immediate challenges, obviously with the introduction of the Euro, the handling of year 2000, these are things you have to keep a focus on as well as doing the day to day business. But I don't see any one particular step such as the prospect of joining a global alliance as a panacea to cover all the structural ills of the industry and of the business. I mean the balance of load factors, yields, unit cost, will remain as delicate as ever and you know just continued concentration on unit cost in the airline is absolutely essential. We can't, no matter what good revenue returns we might be getting at the moment, we can't

take our eye off that. We have a clear commercial view on the profit targets looking forward but we also have a clear customer focus and we have a strategy that we think will work for Aer Lingus and will create a better airline in the only alliance that really matters which is ultimately the alliance with our customers. I also know we have the support of the government in this pursuit but it is support in a form that is appropriate for now and in the future, not as it was in the past. I'd like to just sum up my views on how I think Aer Lingus will respond to the future in a deregulated future by recounting a story told by the late President Eisenhower about a passenger in a cab in Washington. As the cab was passing the National Archive building, he noticed a motto carved in stone which said, 'What has passed is prologue'. Knowing that taxi drivers the world over know everything, the passenger asked the driver what this meant and he replied, 'that's just bureaucrat speak. It means you ain't seen nothing yet.'

Thanks for inviting me along and good luck with the rest of your conference.

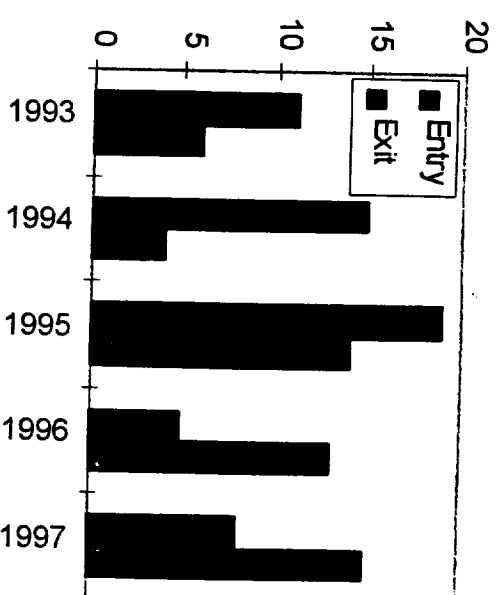
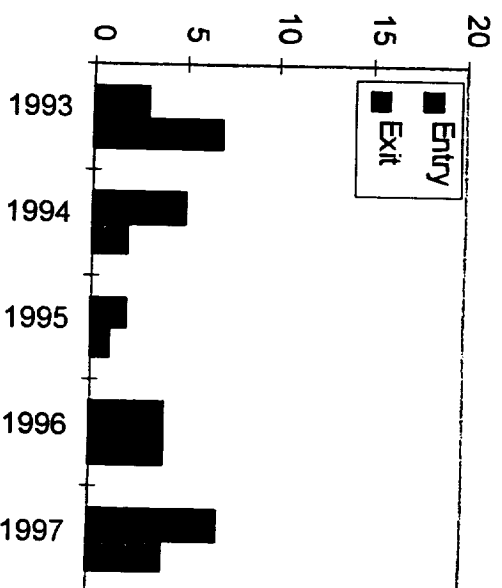
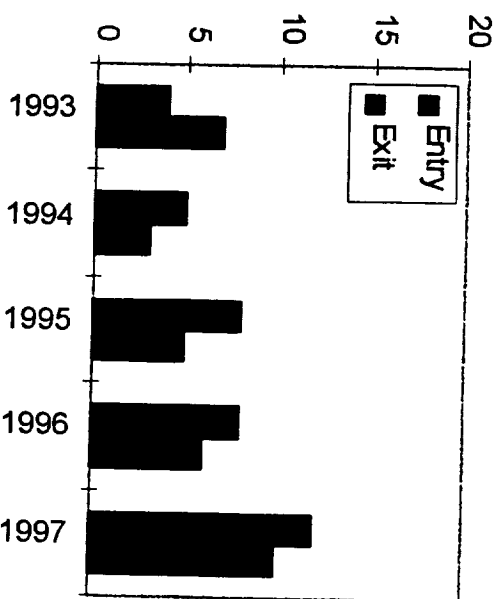


**ATRG Dublin Symposium  
Air Transport in the New Millennium: Opportunities  
in Competitive Markets**

**Doug Andrew**  
Group Director, Economic Regulation  
Group, Civil Aviation Authority, UK

**Plenary Session :  
European Air Transport in the New  
Millennium  
20<sup>th</sup> July 1998**

# Airline Entry and Exit: 1993 to 1997

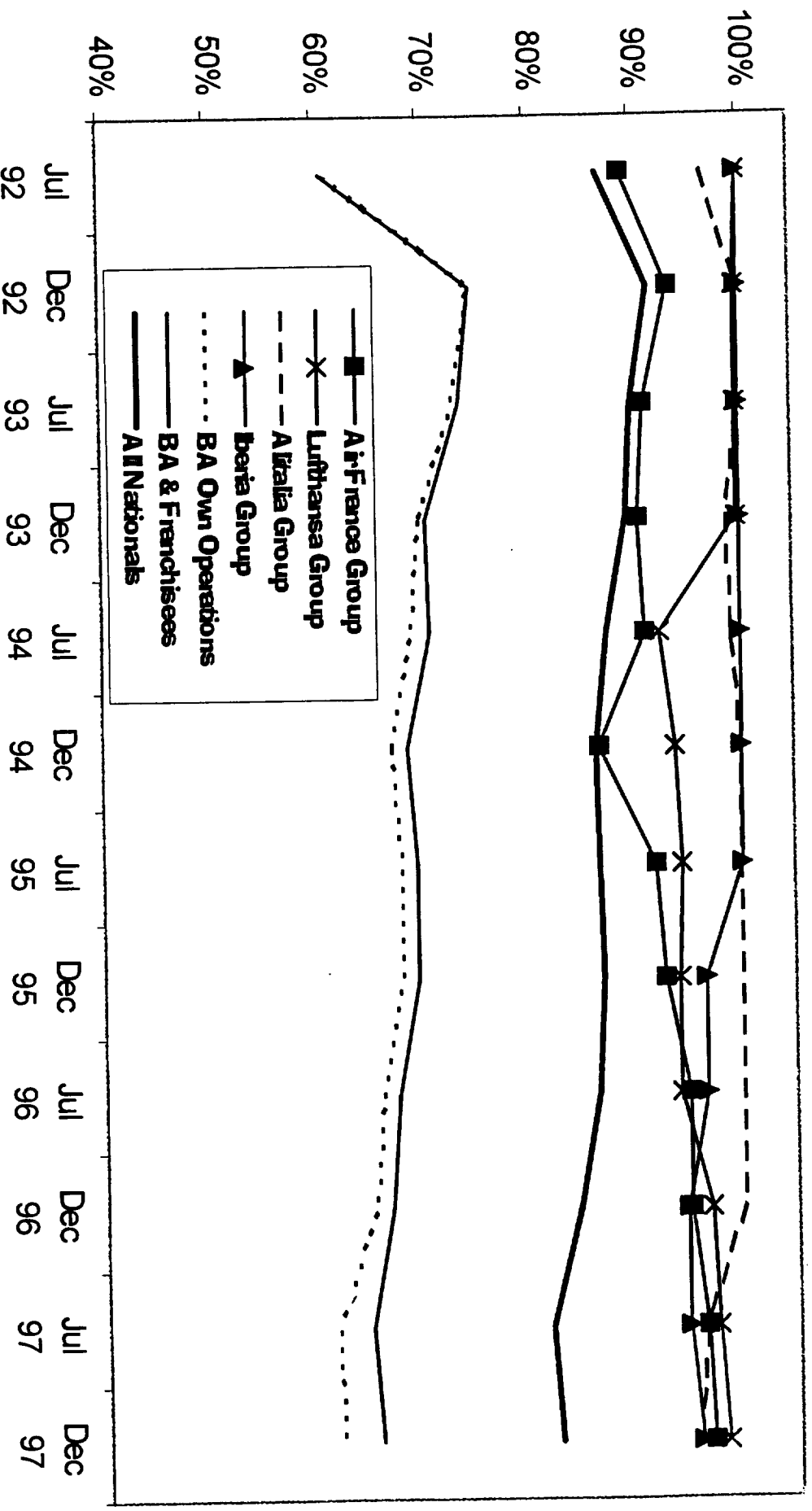


**Operators of  
Larger Aircraft  
(Jets with 70 Seats or More)**

**Operators of  
Medium-Sized Aircraft  
(20 to 70 Seats)**

**Operators of  
Small Aircraft  
(Less than 20 Seats)**

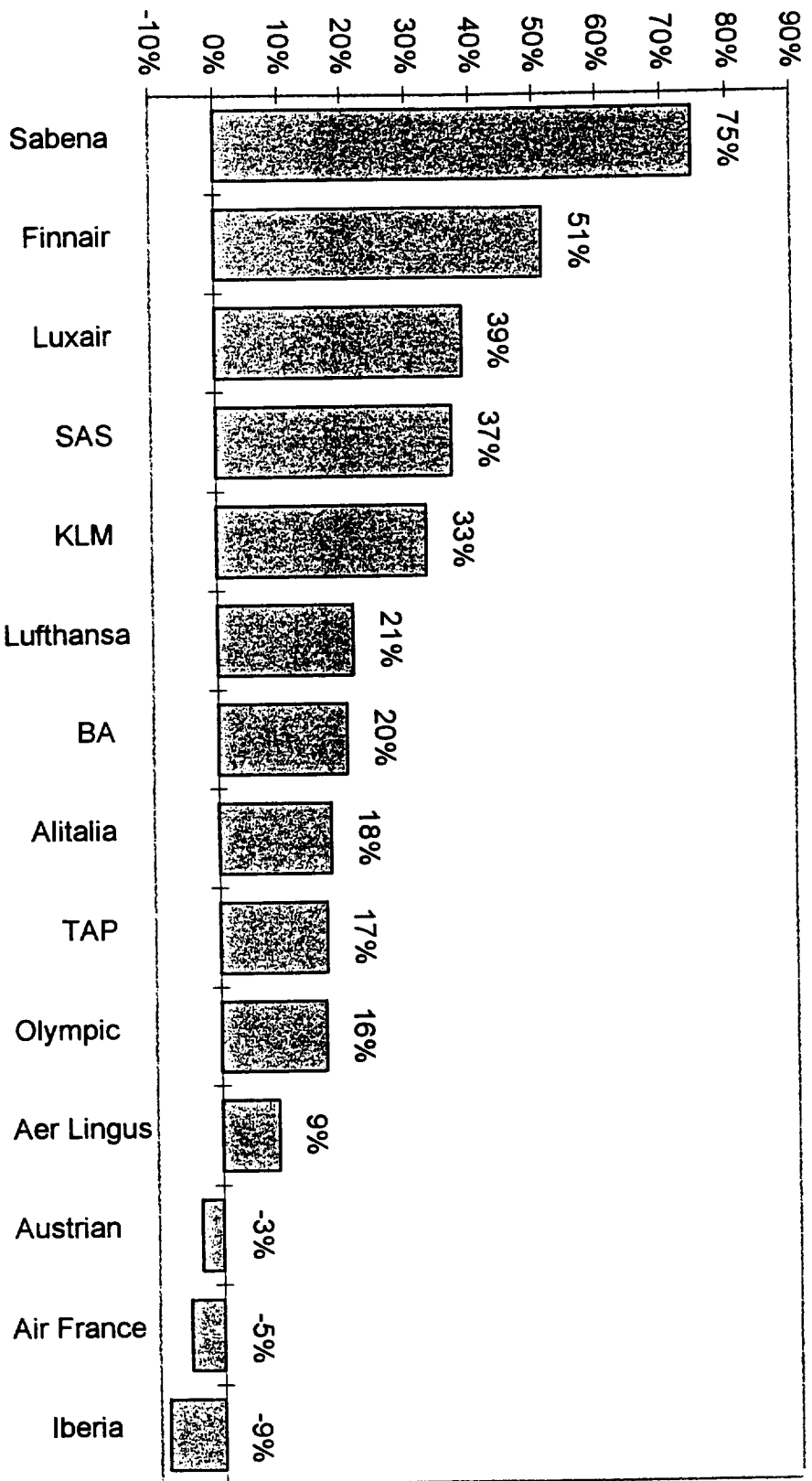
# National Airlines' Shares of Output on Major International Routes



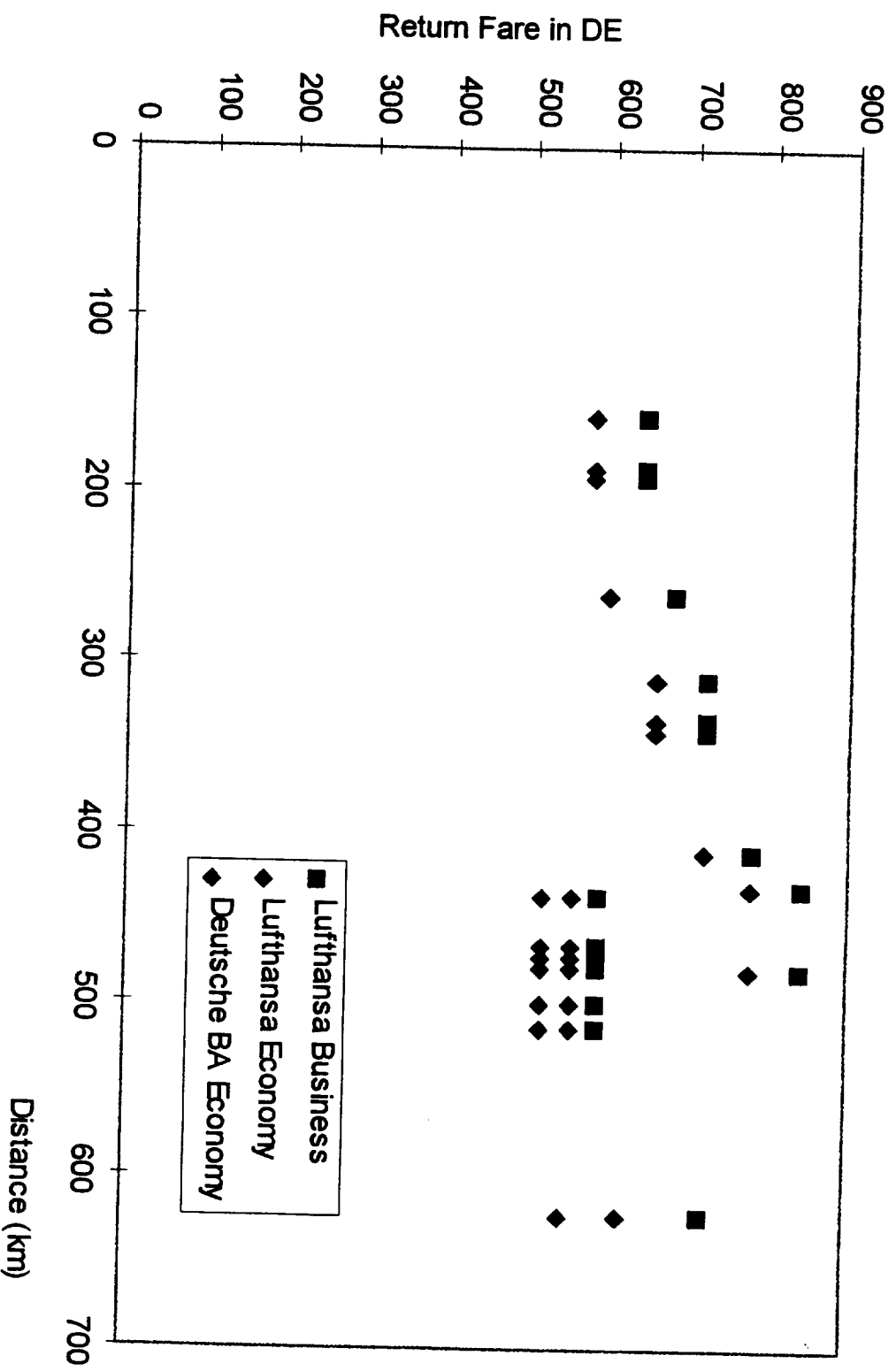
# Domestic Scheduled City-Pair Routes

<i>Routes</i>	<i>Monopoly</i>	<i>Two or More Competitors</i>	<i>Total</i>
December 1992	673 90%	73 10%	746
December 1997	675 81%	154 19%	829
<i>Flights</i>			
	<i>Monopoly</i>	<i>Two or More Competitors</i>	<i>Total</i>
December 1992	51,885 74%	18,557 26%	70,442
December 1997	47,874 52%	44,300 48%	92,174

# Growth in Output on European Routes 1992 to 1996



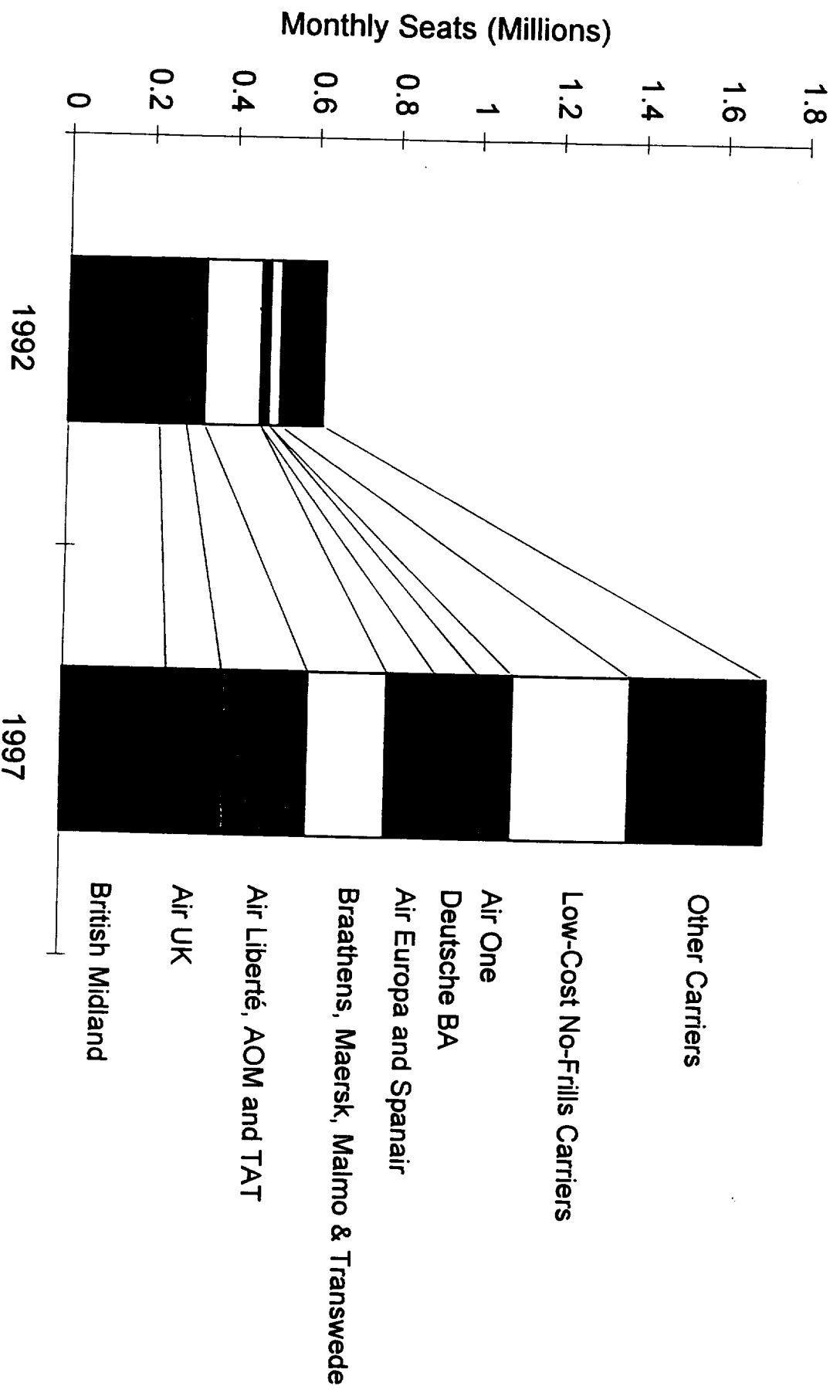
# Fully Flexible Fares within Germany (February 1997)



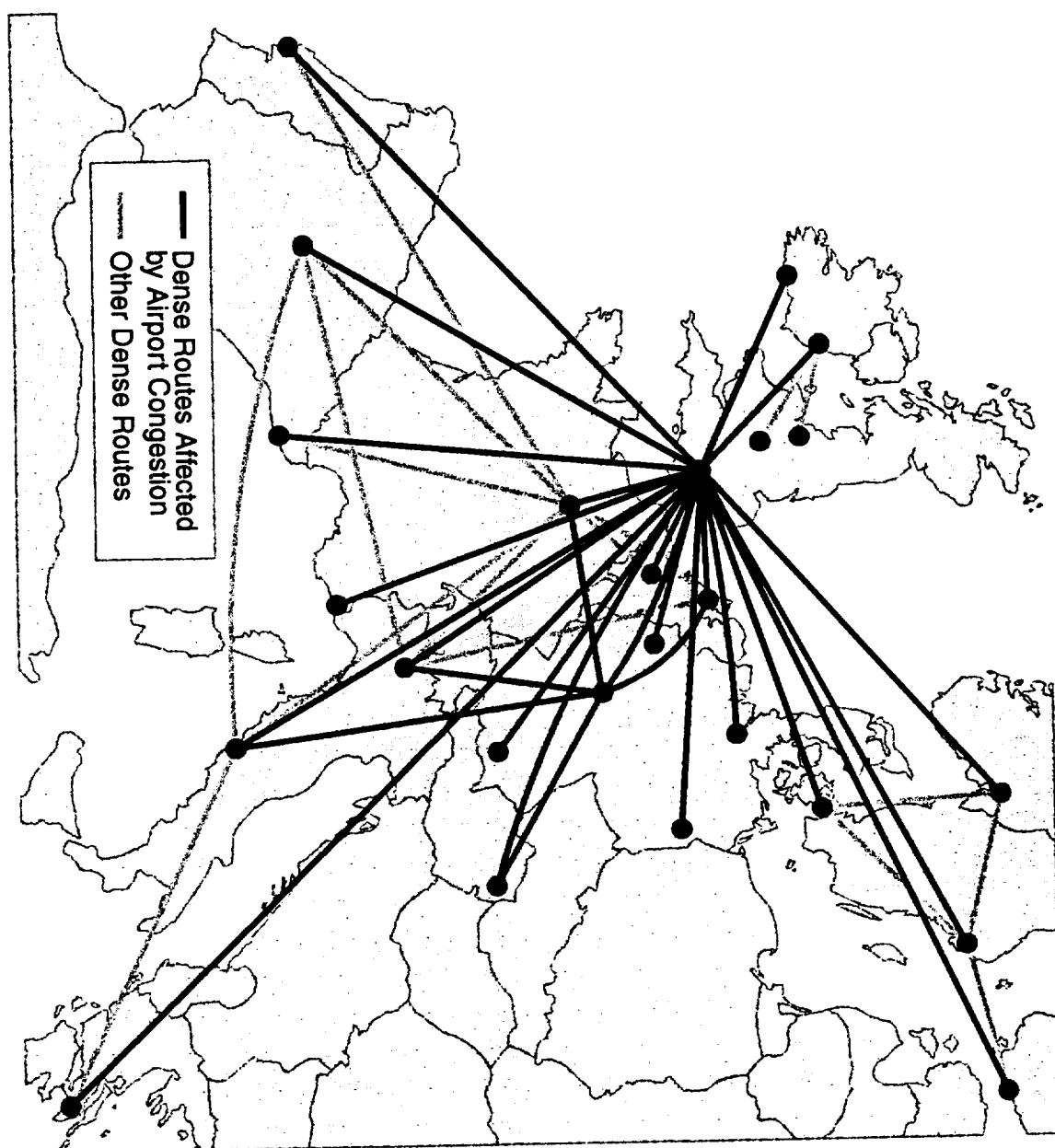
# Declared Hourly Runway Capacities for Summer Busy Periods

Single Runway				Parallel Runways				Converging Runways			
	1993	1995	1998		1993	1995	1998		1993	1995	1998
Gatwick	36-45	40-47	42-48	Heathrow	77-79	77-81	75-84	Stockholm	63	66	70
Manchester	41	42	45-47	Paris(CDG)	76	76	76-84	Zurich	60	60	66
Geneva	30	30	35	Copenhagen	74	76	81	Vienna	30	45	54
Dusseldorf	30	30	34	Munich	68	70	80	Madrid	35	30-50	50
Milan(Linate)	24	22	32	Frankfurt	68	70	76	Barcelona	28	30	47
Athens	30	30	30	Paris(Orly)	70	70	70	Hamburg	40	42	45
				Brussels	53	60	64				
				Rome	50	56	63				
				Milan(Malpensa)	30	30	26				

# Output of Small/Medium-Sized Airlines







Copies of  
CAP 685  
"The Single European Aviation Market:  
The First Five Years"

are available from:

Westward Digital Ltd  
37 Windsor Street  
Cheltenham  
Gloucestershire  
GL52 2DG

Tel: 01242 235151  
Fax: 01242 584139

Price £25.00 plus £4.80 postage & packing

Published in June 1998, CAP 685 reviews developments over the first five years of the single market, and updates the Authority's analysis in two earlier documents, CAP 623 and CAP 654. It examines changes at the industry and the route level in international and domestic markets within the EU, and seeks to identify remaining barriers to effective competition between airlines and to draw out lessons for the future.

51-01  
041257  
385382

# **Reflections on the European Aviation Industry**

**David M Kennedy**

*Paper Presented at the  
Air Transport Research Symposium  
University College Dublin  
July 20, 1998*

## **Reflections on the European Aviation Industry**

In my younger days I am sure that if I had been invited to deliver a paper to an august symposium such as this, I would have selected a more ambitious title such as "The Future of European Air Transport in the 21st Century". Today however, I am less brash and certainly less ambitious. Thirty six years of association with this industry has thought me a degree of humility and an awareness of my own fallibility (as well as that of most commentators) in predicting the future of European air transport.

Accordingly I have titled this brief paper "Reflection on the European Air Transport Industry". What I intend to do is to identify some of the important themes or driving factors in the industry today, to try to understand their importance in the overall scheme and speculate briefly as to how they might develop in the future.

These themes are as follows:

- 1. Basics of Success**
- 2. Industry Profitability**
- 3. Alliances**
- 4. Government Regulation**
- 5. CRS's**
- 6. Airports**
- 7. Fuel**

- 1. Basics of Success**

Let me start with a very simple proposition. The really basic elements in this industry, the determinants which lead to success or failure are substantially the same as they have been in the past and are likely to remain the same in the future. The product has to be safe and it has to be reliable. Reliable means not having undue levels of delays or cancellations, no lost baggage, no excessive queuing at airports, courteous and professional staff, reasonably comfortable seating on aircraft and

clean and well kept facilities. All of these have to be provided at prices, which are affordable in the context of the different market segments, which are being served. These are the basics which are necessary but not sufficient conditions for success. Beyond them the most important factors again remain what they have always been, namely where do you fly and what equipment do you use.

I make these fairly obvious points firstly because they are often forgotten and secondly because I believe that many of the other topics addressed by industry commentators, including the interesting subjects on the agenda of this symposium, are only relevant in so far as they contribute to the basics needed for success. Their relevance therefore has to be assessed on the basis of whether or not they contribute to the fundamental driving forces of the industry.

It is important to remember that even though aviation is now a fairly mature industry it is not always easy to get the basics right. However it is important to get them right most if not all of the time. It is also important to remember that this is an industry which in spite of its high-tech image, its increasing global nature and its highly sophisticated computer modeling techniques is offering a fairly simple and uncomplicated product. The most successful players have been and will continue to be those who do the basics best.

## **2. Industry profitability**

These are heady days for the airlines. After disastrous losses in 1992 and 1993 in the aftermath of the Gulf War, the combination of low fuel prices and growing economies in the developed world, combined with a reasonable balance between supply and demand in most markets led to near record net profits for the international industry of US\$5bn in 1997. The last three years taken together have been the most profitable period in the history of aviation.

Looking forward, the outlook for the industry as a whole appears positive but there are a number of warning signs that should be noted before we all rush out to buy airline stock. In the first place, the net profit of US\$5bn in 1997 represented only 3.4% of total revenues. Even within the more profitable US domestic industry the top

industry performers find it difficult to better a 6% margin. Secondly, the financial crisis in the Asian Pacific foreign exchange and capital markets is having a ripple effect on the industry worldwide. IATA has recently estimated that the impact on airlines operating to, from and within the region is expected to be a reduction of net profit of the order of US\$2bn. Thirdly, a major contributor to the improved financial results of the industry has been the achievement of a reasonable degree of stability between capacity and demand which is pushing load factors to record levels in most markets. Historically, airline managements have always ordered too much equipment in the good days and suffered severe consequences when economies turned down. It would be a surprising change in human nature if this pattern were never to be repeated in the future! Fourthly, it is important to remember that current profits are being achieved on the back of the lowest real fuel prices in the history of the industry. I will return to this point later.

### 3. Alliances

This is the current hot subject in the industry about which all commentators are writing with great excitement. A recent article in "Airline Business" (June 1998) identified a total of 502 alliances in the industry, an increase of 38 % over the number measured last year. Some 11% of the total involved equity investment in some form or another. There are now four major global groupings (including the proposed AA/BA alliance) whose combined group revenues range between approximately US\$30bn and US\$70bn annually.

I am surprised by the unthinking assumption by many industry commentators that these alliances are necessarily "a good thing". In fact I would go further and say that in many cases they represent a bit of a confidence trick on the unsuspecting public. They do offer some limited scope for cost saving within the airline industry itself (e.g. increased purchasing power, elimination of some overhead duplication) but in general they are a zero sum game for the industry collectively. Their main purpose often is to find a way around merger controls and gain an edge over the competition.

There have been different perspectives on alliances in the United States and Europe. Up till fairly recently US Government regulators have been relatively relaxed about

the competitive issues and indeed have encouraged code sharing alliances as a carrot in a number of instances to persuade European Governments to accept open skies. This has even allowed some carriers to undertake what is euphemistically known as "schedule and fare co-ordination", practices which could perhaps more openly be described as capacity and price fixing. I see little difference between this and the former pooling arrangements introduced by Governments at a time when the industry was in its early stages. Such practices became substantially discredited over time but now appear to be re-emerging under different names.

Given the United States concern with anti-trust behaviour in business generally and the much more relaxed view historically taken in Europe about cartels, it is somewhat ironic that the European Commission today appears much more vigilant and concerned about the possibility of anti-competitive behavior and abuses of dominant positions than the US regulators. The detailed investigation of the proposed AA/BA Alliance is the most recent example, but back as far as 1987 the Commission intervened vigorously in the proposed take-over of British Caledonian by British Airways and imposed a number of restrictions which were not to the liking of British Airways or indeed the British Government.

The two year investigation of AA/BA by the Commission has led to the adoption of a preliminary position published earlier this month proposing a number of conditions in respect of the proposed alliance, namely reductions in frequencies, abolition of 267 slots without compensation and as yet unidentified restrictions on frequent flyer programmes, CRS displays, relations with travel agents and corporate customers and interlining. The official Commission statement went on as follows: -

"The Commission considers that, without the proposed conditions, the implementation of the agreement would amount to an abuse of the parties' dominant position on hub-to-hub routes, contrary to Article 86 of the EC Treaty. The Commission also considers that the BA/AA agreement restricts competition contrary to Article 85 of the EC Treaty. The key competition concerns of the Commission are the reinforcement of BA/AA's dominant position on three hub-to-hub routes and the significant barriers to entry that would be created by the alliance."

However, the US airlines have recently been pushing the concept of airlines domestically to a point that is now getting serious attention from politicians and regulators. This year the six largest airlines in the United States have announced their intention of getting together in three separate alliance groupings as follows: - American Airlines/US Airways, Northwest/Continental and United/Delta. Viewed at national level this represents a serious concentration of power in the industry. Viewed regionally the picture is even starker. For example, using the US Department of Transportation figures for the first quarter of 1998, two of these groupings would control between them the following market percentages in each of the following regional markets: -

Region	Percent Market Share Held by Two Groups
East	65%
Midwest	74%
South	80%
Southeast	84%

A submission by the General Accounting Office to the US Sub-Committee on Aviation in June 1998 estimated that if all three alliances occurred, competition would be potentially reduced for about 100 million of the 396 million domestic passengers per year. There would be a partial offset by potential benefits to about 30 million other passengers on routes where two alliance partners could combine to compete with other airlines. The likelihood is that if these alliances were all approved in their present form (which has now to be highly unlikely) frequencies would fall and fares rise on a significant number of US domestic routes.

The proponents of the argument that alliances are generally in the public interest argue some of the following benefits:

- Competitive benefits from multiple competing options
- Seamless on-line service
- Simpler check-in
- Sharing of airport lounges
- Merging of frequent flier programmes.



The argument that there will be competitive benefits from multiple competing options is highly questionable; it is much easier to argue that there will be fewer competing options. The other proposed benefits are generally already available or readily achievable under the existing system. After all, interlining agreements have been part of the industry for many years and have worked pretty effectively in the interests of the consumer. Code-sharing could be described as a form of misrepresentation for a passenger who believes, for example, that he has bought a ticket on Lufthansa and finds out that he ends up on an SAS flight.

There are also many practical problems for the airlines themselves. At a fundamental marketing level what brand image is being projected? Will Air Canada be marketing the Air Canada brand or the Star Alliance brand? Could a smaller airline such as Aer Lingus entering into a partnership with, for example, British Airways seriously expect to be treated as an equal? Achieving serious marketing integration demands a degree of alignment between, for example, respective revenue management systems but this will demand a lot of resources and consume considerable time. Given the degree of promiscuity in the industry in moving from one partner to another and the divorce rate among allegedly permanent partners can such long-term investments be justified? Finally, how do you explain to a British Airways employee that a long-term alliance is essential with a US domestic partner given that the chosen partner was originally United Airlines, then US Airways, then American Airlines and now perhaps US Airways again?

None of the above is intended to suggest that industry consolidation already taking place in the United States will not also occur in Europe or that global alliances are not here to stay. However such consolidation is likely to be complex and fluid and hopefully will continue to be monitored very closely by the European Commission. Such statements as that recently attributed to a senior Lufthansa official to the effect that in future they would tend to confine interlining to members of their own alliance will hardly go unchallenged. The history of strategic alliances in other industries shows many examples of false starts and outright failures as well as successes and aviation is already showing a similar pattern.

#### 4. Regulation

Alliances are not the only area where European regulators are likely to be vigilant to ensure fair competition. The availability of slots at major airport hubs for new entrants in order to prevent dominance of feed traffic by the major operators needs to be an important item on their agenda. The Commission has taken a strong view in a number of cases, (not only with airlines), about alleged abuses of dominant positions causing barriers to entry. For example, Aer Lingus was fined in the early 1990's for refusing to exchange tickets with British Midlands when they commenced services between Dublin and London Heathrow.

At a more general level, regulators in the United States and Europe continue to have somewhat differing approaches to competitive issues and this will need to be addressed. Our United States friends have not been slow in the past to claim extra-territorial jurisdiction for their anti-trust competition laws and there is a lot of scope for serious misunderstanding and disagreement if a more harmonised approach to regulation cannot be achieved.

On a local issue I would express the hope that the current restrictions on Atlantic services to and from Dublin, which have been partially eased in recent years, will soon be lifted totally. The original policy was introduced to protect Shannon Airport but led to severe distortion of the market and cost Aer Lingus many millions of pounds over the years in traffic diverted over London. Although the current policy does allow direct non-stop operations from Dublin to the United States, at least 50 % of the services offered by carriers have to be to and from Shannon. At present there is at least one major US carrier that is deterred from giving serious consideration to providing regular services to Dublin by this restraint. Continuation of this policy would eliminate any possibility of developing Dublin Airport further as an international hub.

competitive advantage in the years ahead and possibly even allow it over time to challenge Heathrow as the main international airport in Europe.

## 7. Fuel

I have already referred to the crucial importance of low fuel prices as a factor in the current profitability of the aviation industry. However, in looking down through the agenda for this symposium, I was struck by the absence of any reference to it. It reminded me of the importance of the dog in the Sherlock Holmes story about whom the significant fact was that he did not bark!

The three major crises of the last 25 years in aviation in 1974, 1980 and 1991 were all precipitated by a sharp and unpredicted increase in fuel prices. Depending on route structure, fuel prices today generally comprise approximately 15% of an airline's total expenditure. In those three crisis years and the years immediately following, that figure went up in many cases to 25% or even 30%. The consequences of that on an industry with profit margins ranging between 0% and 6% were indeed profound.

The pundits today believe that one can reasonably plan for the continuation of low fuel prices. This is probably correct as a short to medium term assessment but it ignores the possibility of major political upheavals. Those of us who experienced at first hand the traumas of previous fuel price increases of 100% and 200% will remember that previous commentators did not forecast the Yom Kippur War of 1973, the fall of the Shah of Iran in 1979 or the invasion of Kuwait in 1990.

Harold MacMillan once commented that the real dread of politicians was 'Events, dear boy, events'! In looking ahead we tend to assume stability and disregard the possibility of sharp discontinuities. If we do in some form or another have a replay of history especially in the Middle East, then I would suggest that many, if not all, of the papers prepared for this symposium (including this contribution) will be of little value as a guide to the future of aviation in Europe in the new millennium.

52-09  
04/10/90

# Benchmark Airport Charges 385549

A. de Wit, Directorate General Civil Aviation (DGCA)<sup>1</sup>  
N. Cohn, Hague Consulting Group (HCG)<sup>2</sup>

## 1. Introduction

### 1.1 Objectives

The Netherlands Directorate General of Civil Aviation (DGCA) commissioned Hague Consulting Group to complete a benchmark study of airport charges at 28 airports in Europe and around the world, based on 1996 charges. This study followed previous DGCA research on the topic but included more airports in much more detail. The main purpose of this new benchmark study was to provide insight into the levels and types of airport charges worldwide and into recent changes in airport charge policy and structure.

The 1996 Benchmark Airport Charges study was completed for a selection of important passenger and freight airports and included a wide variety of aircraft types. Airport charges as of July 15, 1996 were calculated for each aircraft type at each airport<sup>3</sup>, based on one landing and one take-off from/to an international airport by a non-domestic carrier (one international turnaround). The calculations were performed using the 'Airport Charges Model' (ACM), which was developed for DGCA.

The 1996 study does not include handling or fuel charges. DGCA and HCG intend to include these charges in a 1997 update.

The 1996 Benchmark Airport Charges report was used by DGCA for:

- gaining insight into the competitive position of Schiphol in terms of airport charges;
- verification of the findings of other research into Schiphol's competitive position, both for parliamentary questions and as input for an international comparison of infrastructure;
- data input for research projects carried out by DGCA and other organisations;
- insight into the ways in which airports and governments in different countries include the environmental costs of aviation activities in their charging systems;
- background information for the revision of charges at Schiphol.

This paper describes the 1996 analysis. More detail regarding input data and assumptions, as well as a comparison between 1995 and 1996 daytime airport charges in Europe, may be found in the DGCA publication 'Benchmark of Airport Charges 1996'. It is intended that this work be repeated every year in order to follow developing trends and provide the most up-to-date information possible.

<sup>1</sup> P.O. Box 90771, 2509 LT The Hague, Netherlands.

<sup>2</sup> Surinamestraat 4, 2585 GJ The Hague, Netherlands.

<sup>3</sup> A small number of exceptions were made for airports with seasonal peak charges.

## 1.2 Background

The importance of determining and tracking airport charges across different airports has been made clear by recent developments in aviation:

- Due to the stiff competition in the aviation sector, airlines are constantly looking for ways of minimising costs. This includes minimising costs that are to a limited extent under the direct control of airlines, such as airport turnaround costs. The annual ICAO report, "Financial Data", contains information about the cost structure of a number of airlines. According to this source, airport charges make up about 5% of the costs of large, international airlines. For smaller, short-haul airlines the percentage can be as much as 15%<sup>4</sup>.
- The costs of negative externalities related to the environmental impact of aviation activities are increasingly being quantified and passed through to the airlines. Fees based on aircraft noise levels and night flight surcharges are examples of this.
- The phasing-out of a large share of duty-free shopping at many European airports may affect the structure and level of their airport charges.

The airport charges discussed in this report form only one part of the total turnaround costs at airports. Including handling costs and fuel costs would make the analysis more complete, however, at this time, insufficient data are available to DGCA and HCG. Additional research is required in order to include them in the near future. Current information indicates that total handling charges are approximately 50% as large as total airport charges, and that fuel costs amount to more than the sum of airport charges and handling costs<sup>5</sup>.

## 2.0 Airport charges

The ACM processes several different types of airport charges to complete the comparison of airports and aircraft types. The types of fees included are based primarily on the information published in the 'IATA Airport and En Route Aviation Charges Manual'. While ICAO also compiles airport charge information, IATA provides the most recent data. With further research it may be possible to expand the types of fees included in the ACM calculations, but at this time the list is limited to the charges described here.

**Basic landing fees** are usually based on the maximum take-off weight (MTOW). Some airports charge per tonne while others apply a fixed charge plus a variable charge based on MTOW. There are a few airports that vary these charges by time of day or season (peak/off-peak) or by the frequency of a given carrier's operations. Some airports include lighting in the landing charge.

**Noise charges** require special attention because they are sometimes complicated to calculate and are of increasing importance in public and political debates on airport infrastructure. In this paper, a distinction is made between noise-related landing charges and other noise taxes/charges.

---

<sup>4</sup> R. Doganis, 'The Airport Business', 1992, p. 63.

<sup>5</sup> 1993/1994 handling and fuel costs for a Boeing 747-400 at Amsterdam Airport Schiphol, taken from 'A Comparative Study of User Costs at Selected European Airports', Cranfield University, Department of Air Transport, College of Aeronautics, February, 1994.

Many airports have higher landing charges for noisier types of aircraft (Chapter 2<sup>6</sup> aircraft, for example). In the ACM, the additional landing charges assessed for these aircraft are calculated separately from the basic landing charge. For any given aircraft, the basic landing charge is calculated as the amount to be paid for the cheapest, most advantageous situation (for example a Chapter 3 aircraft). The noise related landing charge is the difference between this basic landing charge and the actual landing charge that must be paid for the given aircraft. Several airports charge an extra tax based on aircraft noise levels that is independent of all landing charges. In the ACM, these noise taxes or charges are included as a separate category.

In some cases the tariff differentiation is based on airport- or country-specific aircraft acoustic group classifications (France, Belgium, Switzerland and Korea). At other airports the ICAO classification is used (i.e. 'Chapter 2', 'Chapter 3').

**Passenger charges** are usually levied for services provided to departing passengers, although some airports charge for both departing and arriving passengers. A number of airports charge lower rates for transfer passengers and infants than for other passengers, while others exempt these types of passengers from charges completely. Some passenger charges are paid by the airlines, some by passengers themselves. For the purposes of this analysis, all passenger charges were included in the calculations as if they are paid by the airlines. This allows for consistent comparison between airports and avoids any second-guessing about how these charges are handled by each airline and each airport.

**Security service charges** are often calculated per departing passenger. In a few cases they are based on MTOW which is then a proxy for the number of passengers.

Some airports charge specifically for **runway lighting charges**. These charges usually apply only to night flights, but may be charged incidentally depending on weather conditions. The charges are usually made per landing and several airports included in the study incorporate lighting charges in their landing charges.

**Aircraft parking charges** are based on the number of hours an aircraft is parked at the airport. In some instances these charges are also related to aircraft weight or wingspan. Most airports provide 1 to 4 hours of free parking time, which is usually enough to allow for a complete turnaround. Others provide free overnight parking or differentiate parking charges by location at the airport (i.e. remote stands).

**Terminal navigation aid charges** cover navigational assistance during arrival and departure. They are commonly charged per arrival and/or departure and are sometimes based on MTOW.

**Aviobridge fees** apply to the facilities used for passenger boarding and alighting. In some cases this is a bus service instead of an aviobridge. These fees could be considered handling charges, but in this study they were treated as airport charges.

**Cargo charges** are usually based on the weight of the loaded or unloaded cargo. Note that the passenger variants in the ACM do not include any passenger/cargo 'combi' aircraft. The cargo charges are only included in the ACM cargo variants.

---

<sup>6</sup> As defined by the International Civil Aviation Organization (ICAO) in 'Environmental Protection, International Standards and Recommended Practices, Annex 16 to the Convention on International Civil Aviation, Volume I: Aircraft Noise', Third Edition, 1993.

## 2.1 Other charges

Fuel costs and handling costs are two important types of airport charges which are not currently included in the ACM calculations. Details concerning these charges are not reported by airports with any consistency and are rarely published. Such charges are also very difficult to generalise across airports and aircraft types because of specific contractual agreements which often exist between airlines, handlers, fuel vendors and airports. The prices agreed upon in these contracts can vary a great deal depending on the supplier and the size of the customer. There are a few other types of charges which are also excluded from the analysis because their interpretation was unclear or because no consistent data were available. These range from fire fighting service, aircraft cleaning, storage facility use and hangar charges to terminal and quarantine surcharges.

## 2.2 Assumptions

Although a good deal of detailed information is available about airport charges, quite a few assumptions are required in order to create a complete and consistent picture of these costs over all airports and aircraft types. These assumptions make comparisons between airports possible. An effort was made to base these assumptions on the most common or average situation. Three of the most important assumptions are given here:

- The total number of passengers in an aircraft is equal to the number of seats in the aircraft multiplied by a load factor of 0.65.
- The number of passengers that are transfer passengers depends on the flight destination and the aircraft type. For example, intercontinental (ICA) flights usually contain a higher percentage of passengers that must transfer to reach the final destination airports than intra-European flights. The same is true for larger aircraft used for longer distances between major hub airports when compared to smaller aircraft used for shorter distances.
- The number of airport parking hours required for a given flight depends on the flight destination and aircraft type (full freighter and passenger aircraft).

In each variant, every aircraft type is assigned to a flight destination group. Table 1 shows how the flight destination group determines the assumed share of transfer passengers and required parking hours for each aircraft. Only flight operations with international origins or destinations are included in this analysis. Domestic operations are not included.

Table 1: Transfer passengers and parking hours

flight destination group	% passengers transfer	parking hours
Europe	20	1
Europe or ICA	30	2
ICA	40	3

In the freight variants, there are two types of freight aircraft which require 5 parking hours (they are assumed to have longer turnaround times). Also important for the freight variants is the assumption that the amount of cargo carried is equal to 70% of the maximum payload of the given freighter.

All airport charges have been calculated in terms of Netherlands Guilders. Exchange rates have been used from July 15, 1996<sup>7</sup> (for the 1995 variant, July 15, 1995<sup>8</sup>).

It is important to note that there are significant differences among airports in which types of charges are levied and in how these charges are calculated. Any comparison or analysis requires interpretation and a number of assumptions. The expertise of a number of persons at the DGCA, Schiphol Airport and at other airports was essential for the completion of this report.

### **3.0 Airport charges model**

The Airport Charges Model (ACM), developed for the DGCA, is a flexible program designed to calculate the airport charges<sup>9</sup> to airlines for a turnaround, based on aircraft type. These charges can be calculated for any number of airports, limited only by data availability. This allows for comparison of airport charges among airports and aircraft types. The user can select the airports, aircraft types and fees which are to be included in the model calculations. The specification of the formulas for calculating the airport charges can be made for each airport and, if necessary, for each time period.

The most important data source for this work was the 'IATA Airport and En Route Aviation Charges Manual'. This source is updated several times per year because airports regularly change both the levels of the fees charged as well as the charging formulas. The fees and formulas in the ACM are based largely on the information contained in this publication. The charges valid as of July 15, 1996 were used except for calculating charges for airports with seasonal peak and off-peak periods. In these cases the published rates for each season as of July 15, 1996 were used. Aside from the IATA manual, many airports and aviation authorities were contacted directly with specific questions and to verify that the IATA information was correct and complete. Additional information was provided by DGCA staff, various airport and civil aviation authorities and the Transportation Office of the Royal Netherlands Embassy, Washington, DC. The Airport Information Publication (AIP) was also consulted, as were several other studies of airport charges. The most important of these were:

- Airport Charges in Europe, Andre Wrobel, Institute of Air Transport, Paris, 1997 and
- User Costs at Airports in Europe, SE Asia and the USA, The Air Transport Group, Cranfield College of Aeronautics, February 1998.

While it would obviously be preferable to calculate charges based on, say, current 1998 tariffs, the IATA manual is not updated quickly enough in order to do so. In addition, in many cases it is necessary to consult airports or civil aviation authorities to clarify specific issues for individual airports, and this feedback process is quite time-consuming.

### **4.0 Variants**

The variants were designed to provide a picture of the relative competitiveness of airports in each of the following market contexts:

- Europe 1995: daytime passenger operations at major European airports

---

<sup>7</sup> Exchange rates were obtained from the Olsen & Associates Currency Converter on Internet. These rates were also checked against rates published in the NRC Handelsblad.

<sup>8</sup> Exchange rates obtained from NRC Handelsblad.

<sup>9</sup> excluding handling and fuel charges.



- Europe 1996: daytime passenger operations at major European airports
- Europe Night 1996: night-time passenger operations at major European airports
- Europe Freight 1996: daytime freight operations at major European airports
- Europe Night Freight 1996: night-time freight operations at major European airports
- Regional 1996: daytime passenger operations at regional airports in the Netherlands and a number of surrounding countries
- World 1996: daytime passenger operations at major airports around the world.

A selection of airports and aircraft types was made for each of these variants. The selection criteria for the airports to be included in each variant were:

- Europe 1996: European airports with more than 4 million international passengers and dominated by scheduled air services;
- Europe Night 1996: the same airports as in Europe 1996;
- Europe Freight and Night Freight 1996: the same airports as in Europe 1996 but expanded to include a few other important freight airports;
- Regional 1996: a number of medium-sized airports were selected in the Netherlands and the five surrounding countries, as well as the main airports in these countries.
- World 1996: This variant includes some of the largest airports in the world based on international scheduled passenger volumes. An effort was made to include airports on all continents.

The selection of aircraft types to be included in the ACM was based on information from the 1996 ABC Guide. The aircraft types most frequently landing at and taking off from the selected airports in each variant were chosen. Also important was obtaining a mix of large and small aircraft types as well as both Chapter 3 and Chapter 2 aircraft. In the freight variants, a mix of the most commonly used freight aircraft was selected.

Table 2 and Table 3 list the airports and aircraft types for each of the 1996 variants. The Europe 1995 variant is also shown for comparison purposes and because it was revised for this report based on more recent data.

Many airports vary their charges by time of day or by season. Each time period is included in the ACM as a separate airport so that clear comparisons can be made. For example, airport charges at London Gatwick have been calculated three times for the Europe 1996 variant: once for the peak period, once for the 'shoulder' period and once for the off-peak period. Averaging the costs across these periods would not allow for realistic comparisons between Gatwick and other airports. Note that 'peak' and 'off-peak' periods can refer to either time of day or season. Note also that in the variants Europe Night 1996 and Freight Night 1996, there are fewer airport entries for which charges are calculated than in the corresponding daytime variants. This is because certain time periods, such as Athens airport peak period, are not applicable for night flight charges.

Table 2: Airports by variant

Europe 1995	Europe 1996	Europe Night 1996	Europe Freight /Night 1996	Freight Regional 1996	World 1996
London (Heathrow)	London (Heathrow)	London (Heathrow)	Frankfurt (Main)	Brussels (Zaventem)	Johannesburg (Jan Smuts)
Frankfurt (Main)	Frankfurt (Main)	Frankfurt (Main)	London (Heathrow)	Charleroi	Sydney (Kingford)
Paris (Charles de Gaulle/Orly)	Paris (Charles de Gaulle)	Paris (Charles de Gaulle)	Amsterdam (Schiphol)	Antwerpen	London (Heathrow)
Amsterdam (Schiphol)	Amsterdam (Schiphol)	Amsterdam (Schiphol)	Paris (Charles de Gaulle)	Luik	Frankfurt (Main)
London (Gatwick)	London (Gatwick)	London (Gatwick)	Brussels (Zaventem)	Oostende	Paris (Charles de Gaulle)
Zürich (Kloten)	Zürich (Kloten)	Zürich (Kloten)	Zürich (Kloten)	Frankfurt (Main)	Amsterdam (Schiphol)
Manchester	Manchester	Manchester	Paris (Orly)	Bremen	Zurich (Kloten)
Copenhagen (Kastrup)	Copenhagen (Kastrup)	Copenhagen (Kastrup)	Rome (Fiumicino)	Münster Osnabrück	Mexico City (Benito Juárez)
Brussels (Zaventem)	Brussels (Zaventem)	Brussels (Zaventem)	Copenhagen (Kastrup)	Nürnberg	Tel Aviv (Ben Gurion)
Rome (Fiumicino)	Rome (Fiumicino)	Rome (Fiumicino)	Luxembourg (Findel)	Erfurt	Caïro (Caïro)
Paris (Orly)	Paris (Orly)	Paris (Orly)	Köln	Leipzig	New York (J.F. Kennedy)
Düsseldorf	Düsseldorf	Düsseldorf	London (Gatwick)	Dresden	Miami (Miami)
Madrid (Barajas)	Madrid (Barajas)	Madrid (Barajas)	Madrid (Barajas)	Paris (Charles de Gaulle)	Los Angeles (Los Angeles)
München	München	München	Istanbul	Bordeaux	Toronto (Pearson)
Vienna (Schwechat)	Vienna (Schwechat)	Vienna (Schwechat)	Milan (Malpensa)	Strasbourg	Chicago (O'Hare)
Dublin	Dublin	Dublin	Athens	Toulouse	Hong Kong (Kai Tak)
Athens	Athens	Athens	Manchester	Bale/Mulhouse	Tokyo (New Tokyo/Narita)
Stockholm (Arlanda)	Stockholm (Arlanda)	Stockholm (Arlanda)	London (Stansted)	Luxembourg	Singapore (Changi)
Milan (Linate)	Milan (Linate)	Milan (Linate)	Stockholm (Arlanda)	Amsterdam (Schiphol)	Bangkok (Bangkok Int.)
Geneva	Geneva	Geneva	Vienna (Schwechat)	Eindhoven	Seoul (Kimpoo)
Helsinki (Vantaa)	Helsinki (Vantaa)	Helsinki (Vantaa)	Lisbon	Maastricht	Buenos Aires (Ezeiza)
Lisbon	Lisbon	Lisbon	Helsinki (Vantaa)	Rotterdam	
			Dublin	London (Heathrow)	
			Milan (Linate)	Belfast (Int)	
			Geneva	East Midlands	
			München	London City	
			Barcelona	Stansted	
			East Midlands	Prestwick	
			Düsseldorf		
			Oslo (Fornebu)		

Table 3: Aircraft by variant

	Europe 1995	Europe 1996	Europe Night 1996	Europe 1996	Freight/Night 1996	Freight Regional 1996	World 1996
Boeing 747 400 passenger	Boeing 747 400 passenger	Boeing 747 400 passenger	Boeing 747 400 passenger	Boeing 747 freighter	McDonnell Douglas DC 10 passenger	Airbus Industrie A320 200	
McDonnell Douglas DC 10	McDonnell Douglas DC 10	McDonnell Douglas DC 10	McDonnell Douglas DC 10	McDonnell Douglas MD 11 freighter	Boeing 757 200 passenger	Boeing 737 300	
Boeing 767 300/300ER	Boeing 767 300/300ER	Boeing 767 300/300ER	Boeing 767 300/300ER	McDonnell Douglas DC 10 freighter	Airbus Industrie 320 200	Boeing 747 400	
Airbus Industrie A300 passenger	Airbus Industrie A300 passenger	Airbus Industrie A300 passenger	Airbus Industrie A300 passenger	Ilyushin IL 76	Boeing 737 300	Boeing 767 300/300ER	
Boeing 757 200 passenger	Boeing 757 200 passenger	Boeing 757 200 passenger	Boeing 757 200 passenger	Boeing 707 freighter	Boeing 737 400	Boeing 757 200 passenger	
Boeing 727 200 passenger	Boeing 727 200 passenger	Boeing 727 200 passenger	Boeing 727 200 passenger	McDonnell Douglas DC 8	Boeing 737 200 passenger	Airbus Industrie A300 passenger	
Airbus Industrie A320 200	Airbus Industrie A320 200	Airbus Industrie A320 200	Airbus Industrie A320 200	Boeing 757 freighter	Fokker 100	McDonnell Douglas MD 81	
McDonnell Douglas MD 81	McDonnell Douglas MD 81	McDonnell Douglas MD 81	McDonnell Douglas MD 81	Tupolev TU 154	Fokker F28 Fellowship	McDonnell Douglas passenger	
Boeing 737 500	Boeing 737 500	Boeing 737 500	Boeing 737 500	Boeing 727 freighter	Saab 2000	McDonnell Douglas DC 10	
Boeing 737 200 passenger	Boeing 737 200 passenger	Boeing 737 200 passenger	Boeing 737 200 passenger	Lockheed L100 Hercules freighter	Canadair Regional Jet	Fokker 100	
McDonnell Douglas DC 9	McDonnell Douglas DC 9	McDonnell Douglas DC 9	McDonnell Douglas DC 9	Boeing 737 200 freighter	Fokker 50	Boeing 727 200 passenger	
Fokker 100	Fokker 100	Fokker 100	Fokker 100			Boeing 737 400	
Canadair Regional Jet	Canadair Regional Jet	Canadair Regional Jet	Canadair Regional Jet			Airbus Industrie A310 passenger	
Fokker 50	Fokker 50	Fokker 50	Fokker 50			Boeing 737 500	
Aerospatiale/Alenia ATR 42/72	Aerospatiale/Alenia ATR 42/72	Aerospatiale/Alenia ATR 42/72	Aerospatiale/Alenia ATR 42/72			Boeing 737 200 passenger	
Saab SF 340	Saab SF 340	Saab SF 340	Saab SF 340			McDonnell Douglas passenger	
						Aerospatiale/Alenia ATR 42/72	
						British Aerospace Jetstream 31	
						Beechcraft super king air 200	

## 5.0 Interpretation Issues

Any review of airport charges between airports has inherent comparison and interpretation problems. While it is clear from section 2 that there are many common elements across airports in terms of the types of charges they levy and how they calculate these charges, there are more exceptions than consistencies. The analysis completed by HCG and DGCA dealt with as many of these as possible while preserving a comprehensible overview across all the airports and aircraft types included. However, there are a number of differences between airports that are important to consider when making international comparisons of charges.

### 5.1 U.S. Airports

Section 2 above reviews the types of charges which airlines are required to pay for airport use. The overall structure of these charges is quite similar at most of the airports included in this study, but the structure of the airport charges at American airports is quite different. Some of the charges made at many European airports, such as lighting, security and parking, are not made at American airports. Likewise, an extra passenger tax is charged for all passengers at American airports (US\$6 per international passenger in 1996) which is not levied at most European airports. The question is how to include these airports in a comparative study. Some sources argue that because this passenger tax is eventually reinvested in the U.S. airport and airspace system (by way of the Airport Improvement Program, or AIP), it should not be included in the calculation of total charges<sup>10</sup>. The reasoning is that the level of airport subsidy in the U.S. is such that the airlines eventually obtain benefits approximately equal to the additional passenger tax they pay.

There are several other differences between U.S. and European airports that make any comparison even more difficult:

- U.S. airport operators are involved in fewer activities than many of their European counterparts, such as handling or air traffic control, and their financial structures in general are quite different.
- Some U.S. airports levy a passenger facility charge (PFC) which goes directly toward financing improvements at that airport. Airports that levy a PFC have their AIP funding reduced.
- At many U.S. airports, airlines participate directly by participating in the financing of new facilities or even by building their own terminals. The financial agreements between airlines and airports vary a great deal among the U.S. airports.
- There are many sources of financing for aviation facilities aside from airport bonds, such as state governments, 'essential services' grants and specific funding for intermodal facilities.

The aim of this study is to calculate the nominal ('face-value') charges to an airline for an international turnaround at each airport. The government passenger taxes and any PFCs are therefore included in the calculations because they are part of the total charges. The analysis of the financial structure of U.S. or European airports is beyond the scope of this study.

---

<sup>10</sup> 'A Comparative Study of User Costs at Selected European Airports', Cranfield University, Department of Air Transport, College of Aeronautics, February, 1994, pp. 17-18.

Furthermore, it is not possible to measure the return of this tax to specific airlines at specific airports.

In order to provide some indication of the relative importance of the government passenger tax, we have calculated the U.S. 'air transportation tax' separately from other passenger charges. It is included in the ACM totals but shows its relative share of total charges separately from that of other passenger charges.

Similar government passenger taxes are charged at British, French and Norwegian airports. The U.K. tax is not earmarked for specific investment in aviation facilities, but it is also shown separately in . The French tax, which is referred to as the air transport cross-subsidization tax<sup>11</sup>, is not included in the 1996 ACM calculations because it was not included in the IATA charges manual. It will be included in the 1997 ACM report. The Norwegian tax is used to subsidize domestic rail operations, but is not applicable in the ACM since Fomebu is only included in the freight variants.

## **5.2 Other factors**

The airport charges contained in this paper are based on published rates from different sources, in some cases modified or calculated according to additional interpretation provided by airports and aviation authorities. It is important to note that the actual charges paid by an airline could differ significantly from the figures shown here. Some negotiation takes place between airlines and specific (usually smaller) airports that can result in individual agreements and different charges on a case-by-case basis. As discussed in the section above, direct or indirect subsidies are not quantified or included in the ACM in any way.

## **6.0 Results**

Some notable results of the 1996 analysis are:

- There are large differences in the composition and calculation of airport charges among the airports (and sometimes even within the countries) included in this study. Airport charges in the United States show the biggest difference compared with those at other airports.
- The charges at Schiphol airport are in some cases different in composition than those at many other airports. The Schiphol charges that are somewhat different from those at many other airports include lower passenger charges for transfer passengers, landing surcharges for Chapter 2 aircraft and a specific noise charge (for financing noise insulation costs).
- Approximately one half of the airports included in the ACM variant in which 1996 European airport charges for daytime passenger operations were calculated have no form of explicit noise charges (noise related landing charges or noise taxes). Of the airports included in the 1996 world-wide variant, two thirds have no such charges.
- The tables below show the five airports with the highest average charges and the five airports with the lowest charges for each variant, for all aircraft types and specifically for Chapter 2 and Chapter 3 aircraft. It is evident from these tables that airports in the UK and Germany as well as the Vienna and Geneva airports are the most expensive in Europe. The German airports are not among the five most expensive when only Chapter 3 aircraft are

---

<sup>11</sup> According to the IATA study, 'Airport Charges in Europe', this passenger tax at French airports was instituted in 1995 and was FRF3 per embarking passenger in 1996 (pp. 40).

considered. Helsinki and Stockholm stand out as very expensive for night operations<sup>12</sup>. On a worldwide basis, New York JFK and Tokyo Narita have the highest charges, followed by other US airports, Frankfurt and London Heathrow. When passenger taxes are excluded from this comparison, London Heathrow appears much less expensive in both its peak and off-peak periods. The lowest airport charges are found in Southern Europe and, for non-peak periods, in the UK. The regional airports in Belgium and Luxembourg also have relatively low average charges. Also notable is the fact that Singapore has low average charges compared to other large airports around the world.

- About half of the airports included in the ACM variants have higher airport charges for night-time operations than for daytime operations. In most cases, the differences in charges have to do with lighting, noise and navaid.
- Smaller, regional airports do not always have lower charges than large mainports. For example, the regional airports in the UK, such as London City Airport and East Midlands, have higher charges than some of the large UK airports.
- The turnaround costs of a freighter are as little as one half those for a comparable passenger aircraft at airports which do not explicitly apply cargo charges. This is largely because passenger, security and aviobridge charges do not apply. For airports which do have cargo charges, the total turnaround costs of a freighter are more comparable to those of a passenger aircraft, depending on aircraft type and the actual cargo rate.
- The average change in airport charges between 1995 and 1996 for the airports and aircraft included in the ACM was between +5% and +9%.
- The competitive position of Schiphol is just below the ten most expensive airports and is comparable with the Paris and Brussels airports (see Table 7: Schiphol rankings in the ACM variants, below). Schiphol charges for Chapter 2 aircraft are higher than for Chapter 3 aircraft. Between 1995 and 1996 Schiphol became relatively less expensive overall but by a small margin.
- The position of the regional airports in the Netherlands is generally in the medium range compared to airport charges at other regional airports.

Figure 1 shows the charges for a daytime turnaround of a B747-400 at 20<sup>13</sup> major international airports, world-wide. In Figure 2, the same charges are shown with the government passenger taxes split out of the passenger charges for the U.S. and U.K. airports. Figure 3 shows charges for a B737-500 daytime turnaround at 22 European airports, and Figure 4 contains the night-time charges at these airports for the same aircraft. Figure 5 shows the charges at European airports for a Chapter 2 aircraft turnaround (DC9-30). Note the sizeable noise-related landing charges at several airports. Figure 6 is an example of freighter aircraft turnaround charges in Europe.

<sup>12</sup> The night charges at Helsinki and Stockholm are incorrectly specified in the IATA manual. They are actually somewhat lower and as a result are overestimated in this study. The 1997 study will rectify this problem.

<sup>13</sup> The ACM calculates charges separately for peak and off-peak periods if specified at a given airport. In such cases, the airport appears more than once in the figures, i.e. 'LHRP' and 'LHRO'.

## 7.0 Recommendations for further research

This paper contains a thorough and highly detailed inventory and comparison of standard airport charges within Europe and throughout the world. The market positions of a wide variety of airports in different contexts can be seen in terms of these airport charges. However, an analysis of airport charges alone does not provide a complete picture of either the costs faced by airlines when using a given airport, or the overall competitive position of that airport. In particular, the costs of fuel and handling are significant and probably at least as important to airlines as airport charges. These and possibly other costs should be further researched and in some form included in the ACM in order to provide a more complete comparison of the costs to airlines of using Schiphol with other airports. This will not be a simple task due to lack of data and the complexity of contracts and agreements between airlines, airports, handling companies and fuel companies.

**Table 4: Airports with the highest and lowest average total charges across all aircraft types included in the ACM variants**

Highest	Europe 1995	Europe 1996	Europe Night 1996	Freight 1996	Night Freight 1996	Regional 1996	World 1996
1	Heathrow Peak	Heathrow Peak	Helsinki	Dusseldorf	Helsinki	London City peak	JFK
2	Manchester peak	Vienna	Frankfurt	Cologne	Cologne	London City off-peak	Tokyo Narita
3	Frankfurt	Manchester peak	Manchester peak	Frankfurt	Dusseldorf	East Midlands peak	Chicago
4	Vienna	Frankfurt	Dusseldorf	Munich	Stockholm	East Midlands off-peak	Heathrow peak
5	Dusseldorf	Dusseldorf	Vienna	Geneva	Frankfurt	Belfast	Frankfurt
lowest							
1	Rome	Rome	Madrid	Athens off-peak	Athens off-peak	Luxemburg	Mexico City 'A'
2	Milan Linate	Milan Linate	Rome	Athens peak	Athens peak	Liege	Singapore
3	Madrid	Madrid	Milan Linate	Gatwick off-peak	Gatwick off-peak	Charleroi	Mexico City 'B'
4	Madrid peak	Madrid peak	Dublin	Gatwick shoulder	Gatwick shoulder	Ostende	Johannesburg
5	Dublin	Dublin	Lisbon low	Stansted off-peak	Stansted off-peak	Stockholm	Seoul

**Table 5: Airports with the highest and lowest average total charges for Chapter 3 aircraft included in the ACM variants**

highest	Europe 1995	Europe 1996	Europe Night 1996	Freight 1996	Night Freight 1996	Regional 1996	World 1996
1	Heathrow Peak	Heathrow Peak	Helsinki	Geneva	Helsinki	London City peak	JFK
2	Manchester peak	Vienna	Manchester peak	Zurich	Stockholm	London City off-peak	Tokyo Narita
3	Vienna	Manchester peak	Vienna	Vienna	Geneva	East Midlands peak	Chicago
4	Gatwick peak	Manchester off-peak	Stockholm	Munich	Zurich	East Midlands off-peak	Heathrow Peak
5	Manchester off-peak	Gatwick peak	Manchester off-peak	Dusseldorf	Cologne	Belfast	Los Angeles
lowest							
1	Rome	Rome	Madrid	Athens off-peak	Athens off-peak	Luxemburg	Mexico City 'A'
2	Milan Linate	Milan Linate	Rome	Athens peak	Athens peak	Liege	Singapore
3	Madrid	Madrid	Milan Linate	Gatwick off-peak	Gatwick off-peak	Charleroi	Mexico City 'B'
4	Madrid peak	Madrid peak	Dublin	Gatwick shoulder	Gatwick shoulder	Ostende	Johannesburg
5	Dublin	Dublin	Lisbon low	Stansted off-peak	Stansted off-peak	Antwerp	Seoul

**Table 6: Airports with the highest and lowest average total charges for Chapter 2 aircraft included in the ACM variants**

highest	Europe 1995	Europe 1996	Europe Night 1996	Freight 1996	Night Freight 1996	Regional 1996	World 1996
1	Dusseldorf	Dusseldorf	Dusseldorf	Dusseldorf	Cologne	Nurnberg	JFK
2	Frankfurt	Frankfurt	Frankfurt	Cologne	Dusseldorf	London City peak	Tokyo Narita
3	Munich	Munich	Helsinki	Frankfurt	Frankfurt	London City off-peak	Frankfurt
4	Heathrow Peak	Heathrow Peak	Munich	Munich	Helsinki	Frankfurt	Chicago
5	Manchester peak	Manchester peak	Stockholm	Geneva	Stockholm	Bremen	Heathrow Peak
lowest							
1	Rome	Rome	Madrid	Athens off-peak	Athens off-peak	Charleroi	Mexico City 'A'
2	Milan Linate	Milan Linate	Dublin	Athens peak	Athens peak	Liege	Singapore
3	Madrid	Madrid	Rome	Gatwick off-peak	Gatwick off-peak	Luxemburg	Mexico City 'B'
4	Madrid peak	Madrid peak	Milan Linate	Gatwick shoulder	Gatwick shoulder	Ostende	Johannesburg
5	Dublin	Dublin	Lisbon low	Stansted off-peak	Stansted off-peak	Antwerp	Seoul



**Table 7: Schiphol rankings in the ACM variants**

	Europe 1995	Europe 1996	Europe Night 1996	Freight 1996	Night Freight 1996	World 1996
number of airports in ACM variant	28	29	25	37	37	27
Schiphol rank all aircraft (1=highest charges)	12	14	13	11	15	15
Schiphol rank Chapter 2 aircraft	12	12	12	11	15	10
Schiphol rank Chapter 3 aircraft	11	14	14	15	20	15

Figure 1

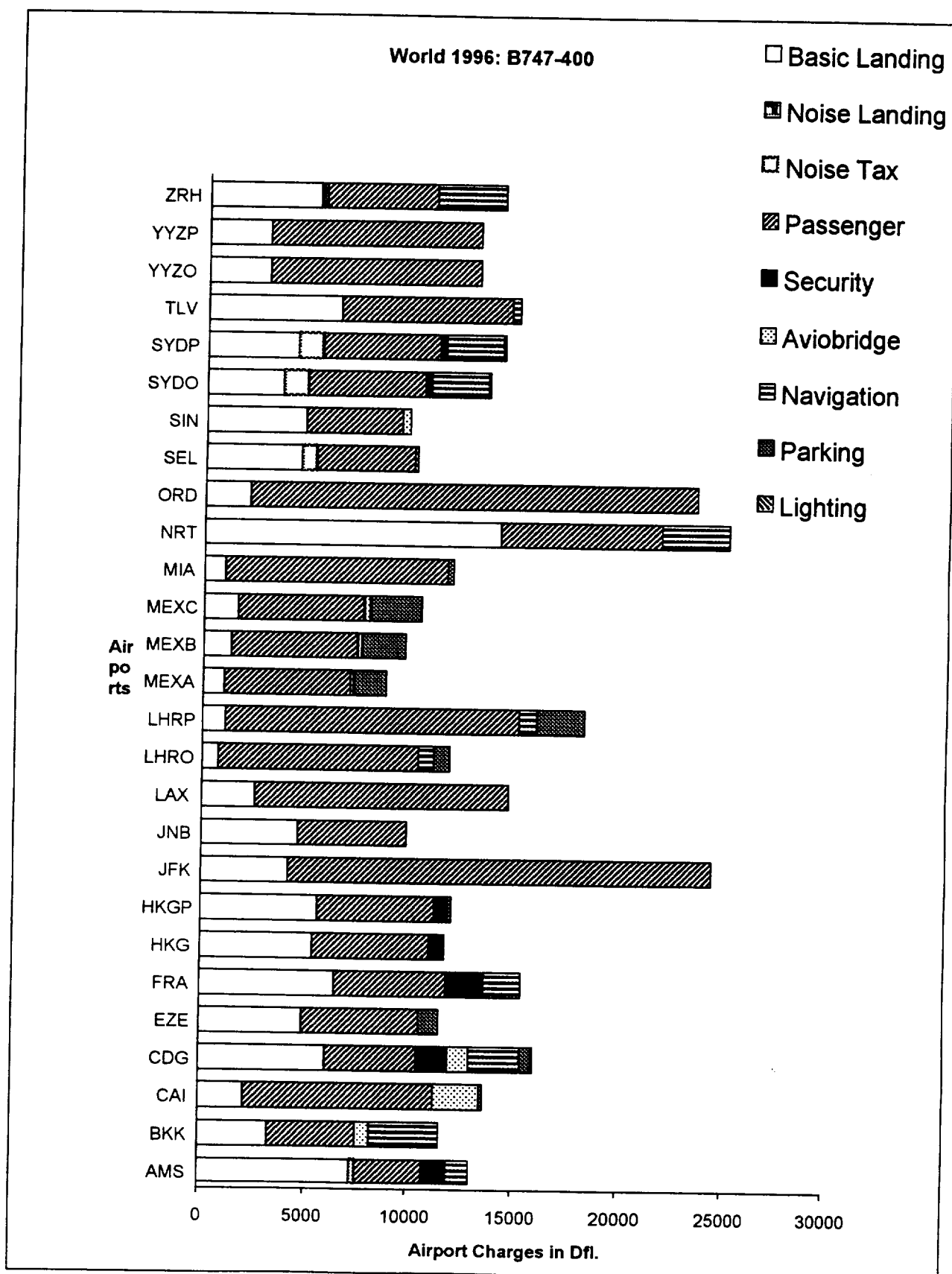


Figure 2

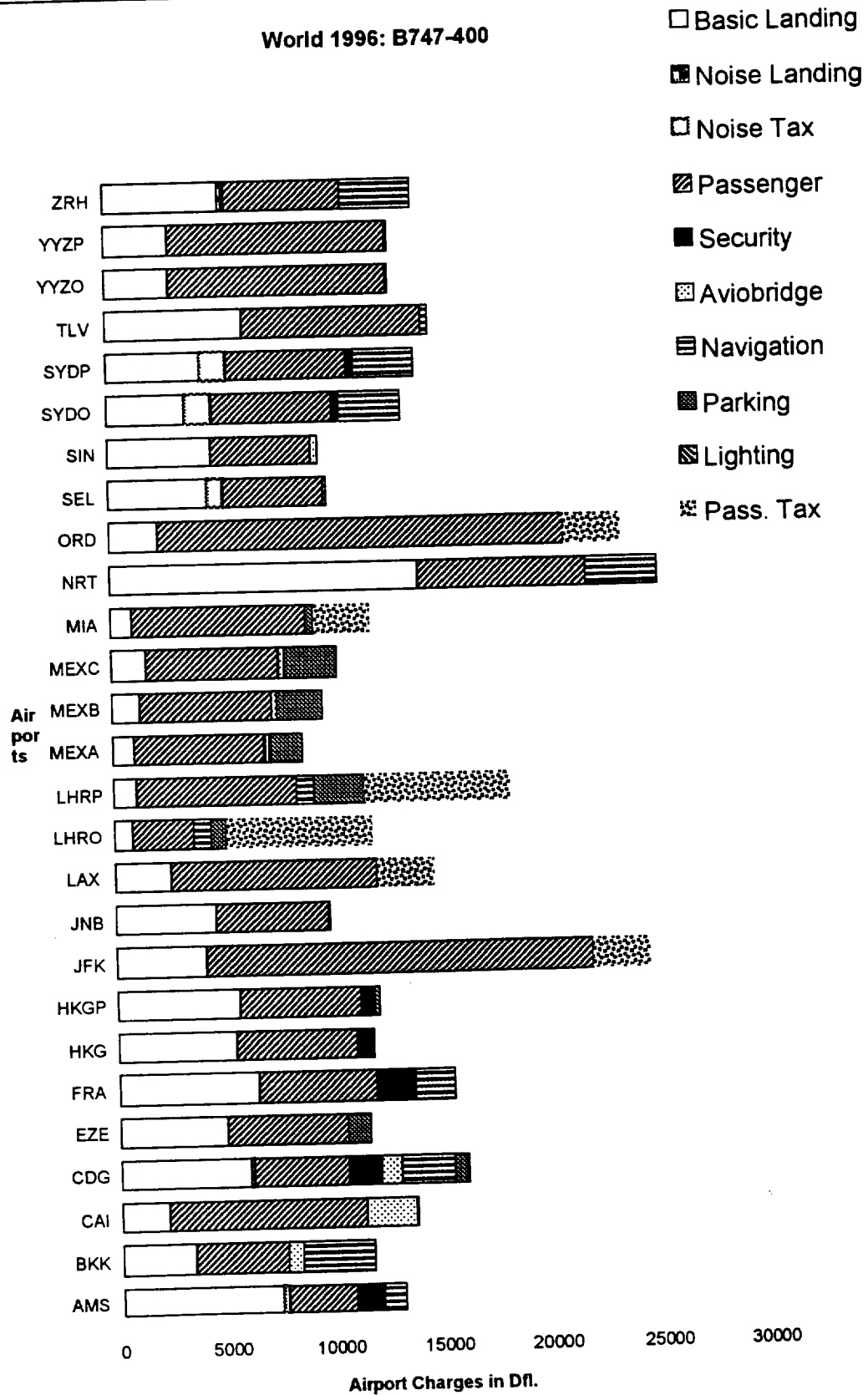


Figure 3

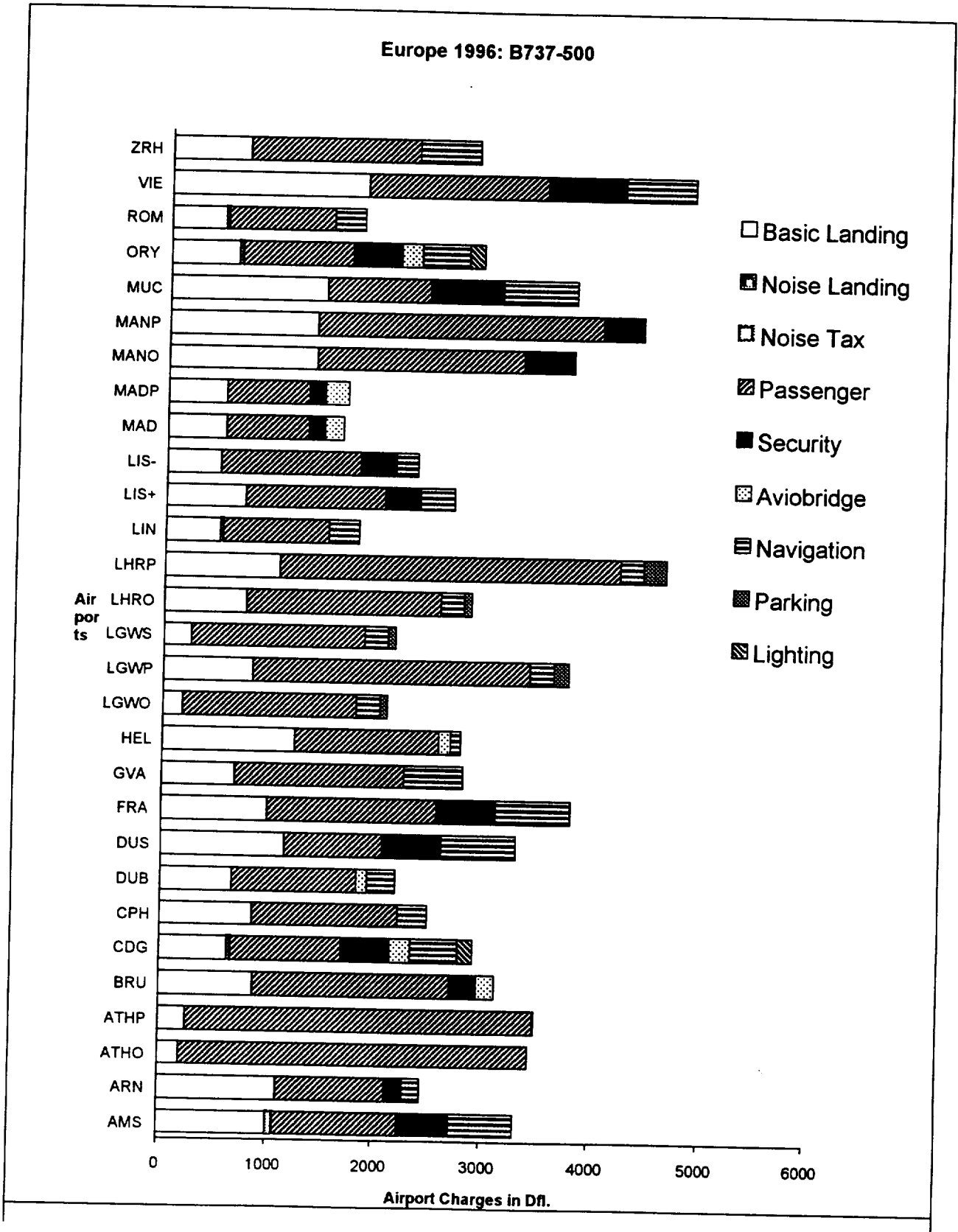


Figure 4

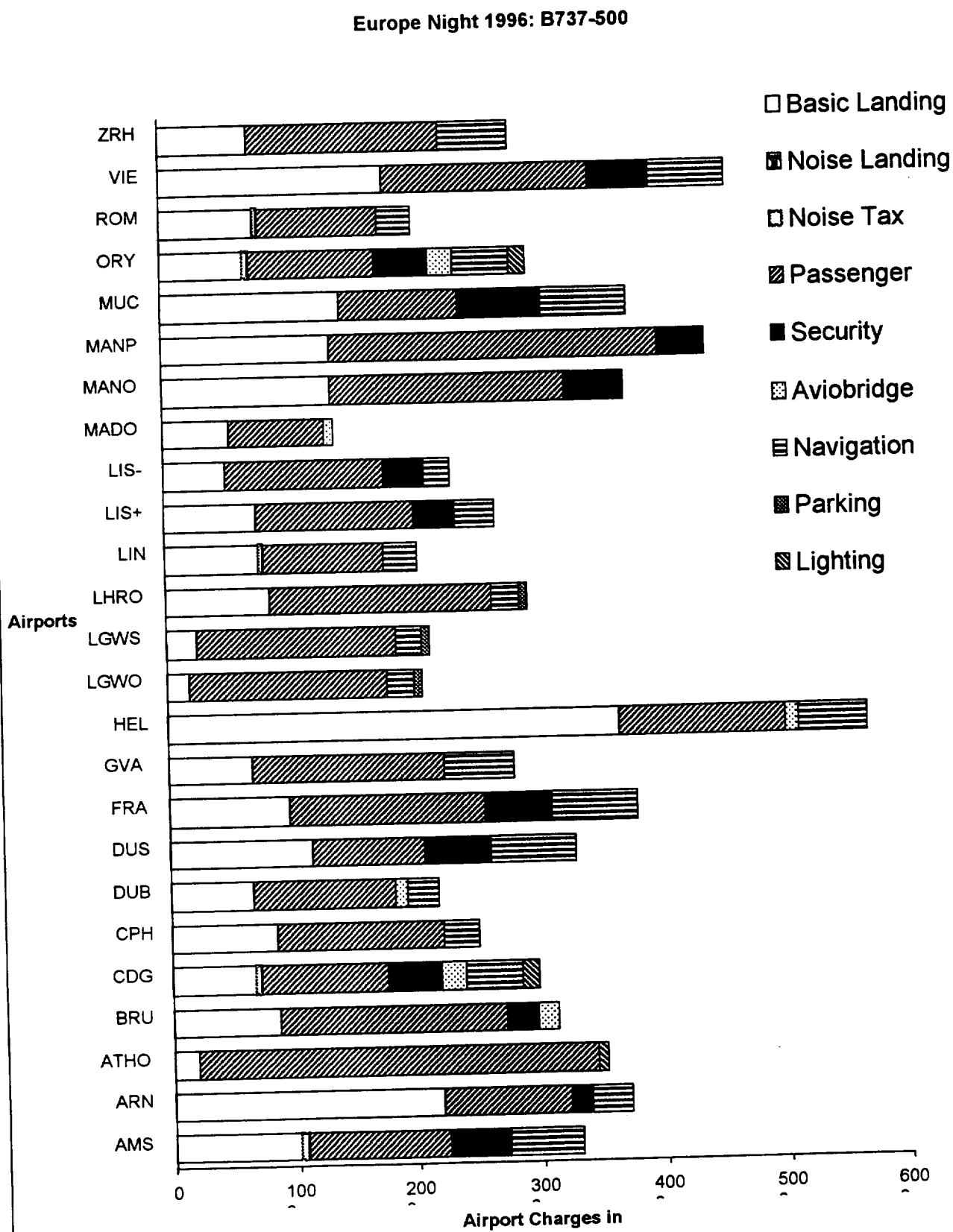


Figure 5

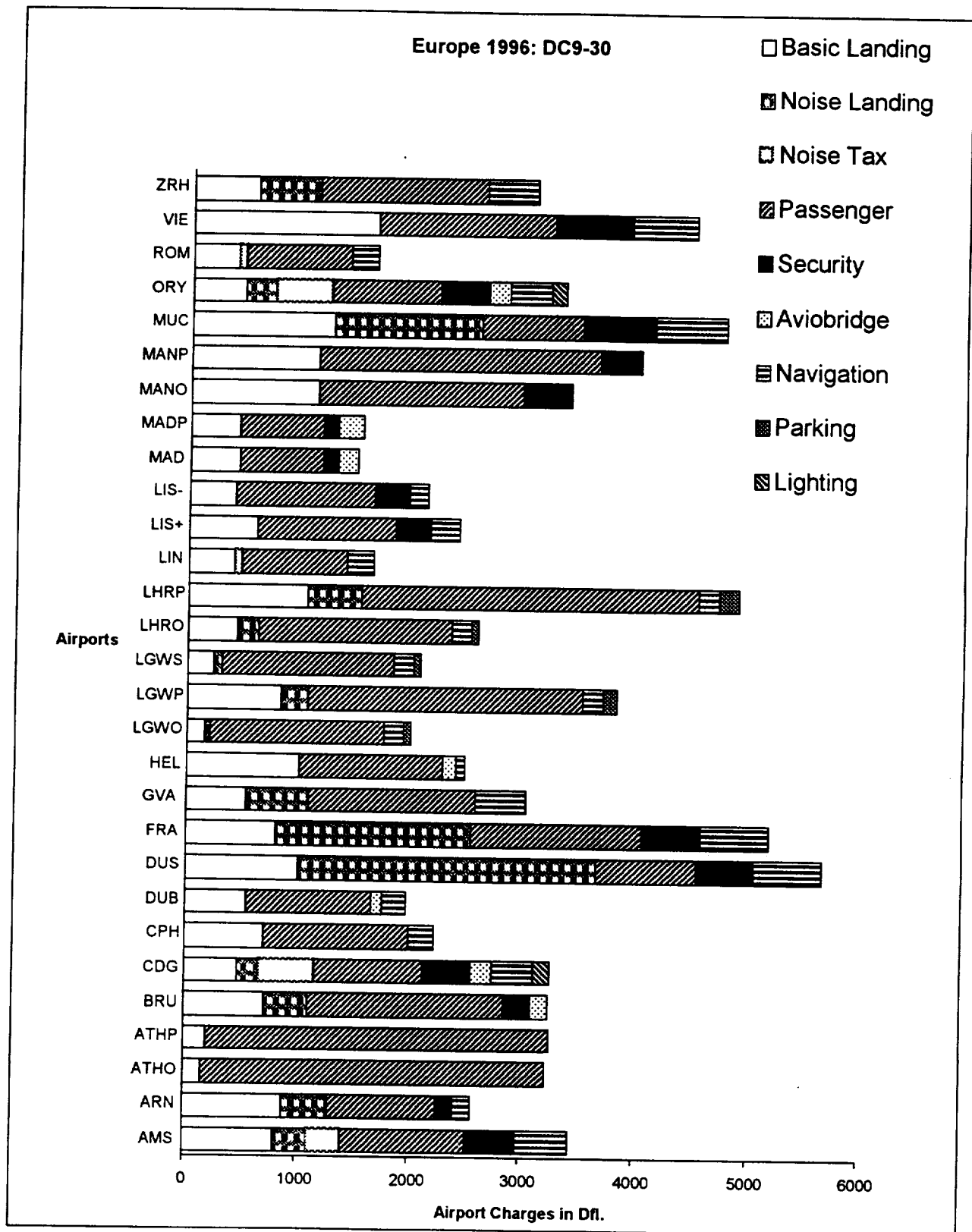
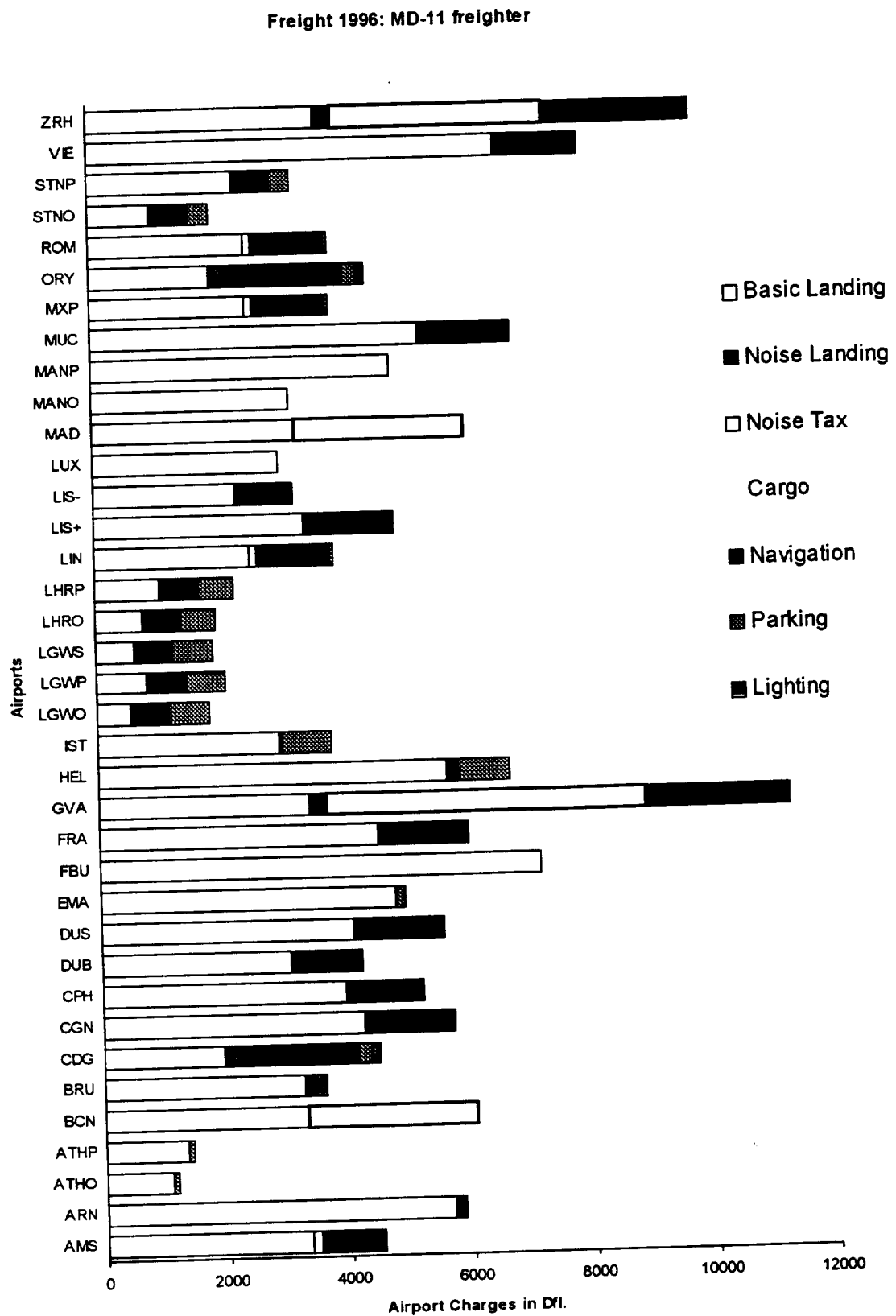


Figure 6



## References

- Cranfield College of Aeronautics, The Air Transport Group, 'User Costs at Airports in Europe, SE Asia and the USA', February, 1998.
- Cranfield University, Department of Air Transport, College of Aeronautics, 'A Comparative Study of User Costs at Selected European Airports', February, 1994, pp. 17-18.
- Doganis, R., 'The Airport Business', Routledge, London, 1992.
- International Air Transport Association, IATA Airport and En Route Aviation Charges Manual, Geneva, 8 August 1996.
- International Civil Aviation Organization (ICAO), Environmental Protection, International Standards and Recommended Practices, Annex 16 to the Convention on International Civil Aviation, Volume I: Aircraft Noise, Third Edition, 1993.
- ICAO, Financial Data Commercial Air Carriers, Digest of Statistics no. 439, 1995.
- Imes, S., 'Airline Passenger Facility Charges: What Do They Mean for an Ailing Industry?' in Journal of Air Law and Commerce, Vol. 60, no. 4, pp. 1039-1089.
- Havengeldregeling per 4 April 1996, Amsterdam Airport Schiphol.
- Havengeldregeling per 1 April 1996, Rotterdam Airport BV.
- Havengeldregeling 1996, NV Vliegveld Welschap.
- Havengeldregeling 1996, Ingangsdatum 1 April 1996, NV Luchthaven Maastricht.
- Olsen & Associates, Olsen Information System - Currency Converter, <http://www.olsen.ch>.
- Staatsblad van het Koninkrijk der Nederlanden, Jaargang 1996, no. 26: 'Beschikking van de Minister van Justitie van 9 januari 1996, houdende plaatSingaporeg in het Staatsblad van de tekst van de Luchtvaartwet, zoals deze luidt met ingang van 22 november 1995', Hoofdstuk VII 'Slotbepalingen'.
- Toelichtingen en Toepassingen, Havengeldregeling, Amsterdam Airport Schiphol.
- Wrobel, A., 'Airport Charges in Europe', Institute of Air Transport, Paris, 1997.



**Duty Free Shopping: its importance as a source of revenue in Spanish airports.**

**Author:** Roberto Rendeiro Martín-Cejas

**Institution:** Universidad de Las Palmas de Gran Canaria

**Address:** Facultad de Ciencias Económicas y Empresariales

Edificio Departamental Modulo "D"

Campus de Tafira

Las Palmas de Gran Canaria C.P. 35017 Spain

**Telephone:** (928) 45-28-08

**E-mail:** Roberto@empresariales.ulpgc.es

## **Abstract**

The new Community regulations governing Duty Free Shopping come into force on 30<sup>th</sup> June 1999. From this time onwards Duty Free Shopping will cease to exist within the EC. As a result of this development, airports in Spain are going to lose a major source of revenue. As Duty Free Shopping is of such significance in the context of the range of services provided by the Spanish airport network, we believe that the impact that the new regulations will have is worth evaluating. With this aim in view, we have drawn up an ad hoc revenue model in order to examine the influence which variables such as international travel and Duty Free Shopping (DFS) have on the generation of income in the Spanish airport network. We will attempt to evaluate loss of earnings in airports of the type which could be considered ideal for DFS but which nevertheless lack this type of service.

## 1. Introduction.

Duty Free Shops (DFS) were originally establishments, which basically offered tax-free goods such as perfumes, tobacco products and spirits. Such items were designed for last minute shopping. Nowadays, however, all sorts of items are on sale, such as designer clothing and eyewear, or electronic appliances like cameras, radios, computer goods and many others.

Only 11 airports in the Spanish national network possess DFS (Alicante, Almería, Barcelona, Ibiza, Madrid/Barajas, Málaga, Menorca, Palma de Mallorca, Reus, Sevilla and Valencia). The overall revenue from DFS at these airports in 1991 was some 21 million pounds. The following year this figure increased by almost 21%, representing 7.3% of total income and some 20% of non-aeronautical income.

The application of the Single European Act will, amongst other things, remove customs barriers between EC member states. Member states will be permitted to continue with tax exemption on goods purchased in DFS until 30<sup>th</sup> June 1999. After that time the facility will cease to exist. As a result, a major source of revenue for Spanish airports will be lost. For this reason, and owing to the importance of this activity in the context of the range of services offered by the Spanish airport network, we consider that it is desirable to quantify the impact that the application of the new regulations will have.

## 2. The Model

By means of an ad hoc model (see Doganis, 1973), we will attempt to evaluate the influence of DFS with respect to income generation in the Spanish airport network. The model in log form is as follows:

$$\ln(I) = \ln(\alpha) + \beta_1 \ln(PN) + \beta_2 \ln(PINT) + \beta_3 D + \mu$$

where:

$I$  = total revenue<sup>1</sup>, both aeronautical and non-aeronautical

$PN$  = number of passengers on national flights

$PINT$  = number of passengers on international flights

$D$  = dummy variable

$D=1$  where the airport possesses duty free facilities

$D=0$  where it does not

Dummy variable  $D$  is an attempt to express the influence of DFS on income generation. This must be significant; bearing in mind that it is the largest source of non-aeronautical income for the Spanish airport network.

Of the thirty-one airports included in this study, fourteen produced a surplus. Of these fourteen, nine are tourist airports (i.e. international passenger traffic is greater than domestic traffic). The importance of this type of traffic for income generation in Spanish airports is thus self-evident. The introduction of variable  $PINT$  in the model (number of passengers on international flights) attempts to express this influence. The number of passengers on international flights has a clear influence on income generation, since this type of traffic requires services such as banks, shops, rent-a-car, etc., all of which generate extra income for the airports. Furthermore, planes used on international flights are larger than those used for domestic flights and are thus more profitable from the point of view of landing charges, which increase in accordance with the weight of the aircraft. These considerations lead us to the supposition that the variable for the number of passengers on international flights is relevant to the generation of both aeronautical and non-aeronautical income. In both cases the coefficient estimate sign will be positive.

---

<sup>1</sup> Total revenue is the sum total of aeronautical and non-aeronautical income.

### 3. The Results

The least square estimators are presented on the following table:

Table 1: Income equations (year 1992)  
("T" statistic between brackets )

Dependent Variable	$\alpha$	$\beta_1$	$\beta_2$	D	R <sup>2</sup>	F
Ln TR	-3.9 (-6.1)	0.41 (6.6)	0.39 (9.5)	0.46 (2.4)	0.952	179.2
Ln NAR	-6.25 (-9.4)	0.6 (9.2)	0.28 (6.7)	0.7 (3.4)	0.949	169.8
Ln AR	-3.99 (-5.53)	0.314 (4.5)	0.48 (12.7)	-	0.937	208.3

Ln TR : Natural logarithm of total income.

Ln NAR: Natural logarithm of non-aeronautical income.

Ln AR : Natural logarithm of aeronautical income.

R<sup>2</sup>,F : Coefficient of determination and statistic F.

The dummy variable used to represent the existence or otherwise of DFS facilities was statistically relevant in both cases, although it had a greater influence in the non-aeronautical income model. This confirms the theoretical hypothesis with respect to DFS activity. The coefficient estimated for this variable in the non-aeronautical income model was 0.7<sup>2</sup>, indicating that amongst airports with similar traffic statistics; those, which possess DFS, earn twice as much non-aeronautical income as those, which do not.

The PINT variable was significant in the determining of Spanish airports income and was especially significant in terms of the generation of aeronautical income. However, the relevancy presented by this variable with respect to non-aeronautical income generation indicates, perhaps, the lack of development of commercial activity related to this type of traffic in Spanish airports.

<sup>2</sup> Aeronautical income (airports with DFS)/ Aeronautical income (airports without DFS) =  $e^{0.7} = 2$

The non-aeronautical income per passenger ratio (see table 2) represents non-aeronautical income generated per passenger in the year 1992. Airports such as Lanzarote and Fuerteventura, which do not possess DFS facilities, generated less than half as much non-aeronautical income per passenger as Ibiza and Menorca, although all four airports had similar volumes of traffic. The same is true of Gran Canaria and Tenerife airports with respect to Málaga.

The airports with the highest non-aeronautical income per passenger transported were: Málaga, Madrid/barajas, Barcelona and Alicante. The first and the last of these are airports of a tourist nature - international traffic in both these airports represented about 70% of the total. Income obtained from DFS at both airports represented approximately 50% of the overall figure for commercial activity income. Airports such as Lanzarote and Fuerteventura, on the other hand, where international traffic percentages were 65% and 73% respectively, were at the bottom of the list with regard to non-aeronautical income generation. It is therefore clear that Canary Islands airports suffer a major loss of income as a result of not possessing DFS facilities.

Only eleven of the thirty-one airports covered by the survey possess DFS facilities. This indicates that the development of commercial activity in most of these airports falls below the potential for exploitation, which exists in the majority of them. Nevertheless, such development is limited by factors such as the size and design of terminal buildings and the availability of space. Furthermore, the range of activities, which could be installed, would depend on the individual characteristics of traffic circulation in their respective terminals. Such factors do not come under the control of airport administrators.

Another thing to bear in mind is the "unfair competition"<sup>3</sup> effect that this type of business activity would have on local businesses. DFS within the EC has been stopped for this very reason. The repercussions for the small businesses which have traditionally satisfied local demand could be significant (Doganis, 1992).

---

<sup>3</sup> DFS at Spanish airports is managed by ALDEASA. In accordance with Royal Decree 2417 of 9<sup>th</sup> August 1974, this company possesses a monopoly in that it is the only enterprise authorised by the Spanish State to exploit DFS in Spanish airports.

Table 2: Ratio. (Year 1992)

<i>Airports</i>	<i>Total income per passenger</i>	<i>Aeronautical income per passenger</i>	<i>Non-aeronautical income per passenger</i>
<i>Airport with surplus</i>			
Madrid/Barajas	1037.2	644.3	392.8
Palma de Mallorca	745.1	511.1	234
Barcelona	893.6	542.5	351
Tenerife	699.2	499.3	199.9
Gran Canaria	752.7	538.5	214.2
Málaga	982.4	577	405.4
Lanzarote	631.6	526.9	104.7
Alicante	851.6	513	338.5
Ibiza	765.7	499.7	266
Sevilla	775.2	443.4	331.7
Fuerteventura	660.4	552	108.3
Menorca	718.5	452.2	266.2
Valencia	764.1	474.7	289.3
Bilbao	566	318.8	247.1
<i>Airport with deficit</i>			
Valladolid	573.4	299	74.3
Reus	1334	1150.8	183.2
Zaragoza	1127.1	825.4	301.6
Jerez	540.4	286.2	254.3
La Palma	375.9	245.3	130.6
San Sebastián	377.6	206.4	171.1
Murcia/San Javier	732.1	487.1	245
Pamplona	347.1	261.7	85.4
La Coruña	291	197.7	93.2
Vigo	359.7	198	161.6
Asturias	324.7	187.5	137.1
Almería	681	468.8	212.2
Santander	368.9	211.2	157.6
Granada	350.1	209	141.1
Santiago	615.1	326.7	288.4
Vitoria	549.8	308.3	241.4

#### **4. Conclusions**

According to the results obtained, Spanish airports are losing substantial income because of a lack of development of commercial activity. Canary Island airports stand out particularly in this context, in that they possess ideal characteristics for the implementation of DFS. The amount of international traffic, almost all of which proceeds from EC countries, circulating through Canary Islands terminals, is considerable. Therefore, in the four years remaining before the new EC customs rulings come into effect, Canary Islands airports could take advantage of this opportunity by installing DFS facilities. However, the establishing of DFS facilities in Canary Island airports could have negative financial repercussions for local businesses.

#### **References**

Doganis, R. (1992): The Airport Business. Routledge editions.

Doganis, R. and Thompson, M.A. (1973): "The Economics of British Airport". Transport Studies Group, Department of Civil Engineering, Polytechnic of Central London.

Doganis, R. and Nuutinen, H. (1983): "Economic of European Airports". Transport Studies Group, Department of Civil Engineering, Polytechnic of Central London.



DRAFT-COMMENTS WELCOME

**NON-PARAMETRIC MEASURES OF EFFICIENCY OF U.S. AIRPORTS\***

David Gillen  
Wilfrid Laurier University  
School of Business & Economics  
75 University Avenue West  
Waterloo, Ontario  
Canada N2L 3C5  
dgillen@euler.berkeley.edu

33-09  
041041  
385551  
p14

Ashish Lall  
Nanyang Technological University  
Nanyang Business School  
Room S3-B1A-02  
Singapore 639798  
ashish@direct.ca

---

\* Paper for presentation to the ATRG Conference, Dublin, Ireland, 20-21 July 1998

## Abstract

Conventional non-parametric efficiency measurement relies on superlative index number based measures of total factor productivity. In most instances, this measure is decomposed into various components such as scale effects and technological change. The decomposition usually requires estimation of a flexible cost function. This approach has a variety of drawbacks. Firstly, it is based on a "non-frontier" notion of efficiency. Secondly, it usually requires behavioral assumptions such as profit maximization or cost minimization, and lastly, it requires data on both prices and quantities of outputs and inputs.

In recent years, attention has shifted towards alternatives such as Data Envelopment Analysis (DEA). DEA does not require the assumptions such as profit maximization, or, data on prices and has been used to measure performance of non-profit organizations. DEA based studies typically use cross-sectional data and therefore, unlike conventional index number based studies, are unable to analyze changes in productive efficiency over time. This paper uses panel data on 22 U.S. airports over the five-year period 1989-93 to construct a Malmquist index of productivity change and decomposes it into scale effects, efficiency effects and technical change. The paper also explores the nested relationship between airside efficiency and terminal efficiency and the tradeoffs between lower costs and higher revenues.

## 1. INTRODUCTION

Over the last two decades a great deal of effort and resources have been expended in developing measures of performance for carriers in the different modes of transportation. This had been stimulated by both deregulation and privatization initiatives. Measures of productivity performance, efficiency and effectiveness are now available for railways, airlines, trucking, and public transit firms. The measures range from relatively simple quantities, such as output per employee, to more sophisticated measures such as TFP (Total Factor Productivity) - a standard which takes account of all inputs in the production process. These measures have been used to assess alternative management actions and strategies in developing, for example, more effective means of satisfying the objectives of the owners or operators. They have also been used to measure technical progress and to rank carriers by their productivity gains. In other cases, measures of cost and service effectiveness have been developed in order to evaluate financing for capital projects and changes in public policy such as deregulation.

The motivation for this paper stems from the evolving trends of 'redefining the way in which government operates' and the growing tendency to shift major capital investments and operations in transportation away from direct government control. This can mean anything from privatizing or commercializing infrastructure to creating incentives for managers so that they pursue particular financial targets and perform in a way that maximizes the objectives of the owners. Worldwide this has taken such forms as airport and roadway privatization as well as commercialization through joint public/private ownership or the contracting out of various services. In many cases these enterprises are break-even or not-for-profit. Under such circumstances standard financial measures of performance such as the rate of return on capital or profits are not meaningful. It is also difficult to define a measure of output or service as well.

A major impetus behind the desire to privatize or at least commercialize airports, roadways and ports throughout the world is the lack of investment capital available from governments to meet the needs of these infrastructure to invest in new facilities, terminals and equipment. Furthermore, management is under increasing pressure to wean them from government support by becoming more efficient. Airports, in particular, are recognized as mature 'firms' that should be able to stand-alone and operate without government support or interference.

Continued deregulation of carriers has provided an additional stimulus to improve airport performance. Despite airport charges being only 5-7 percent of total operating costs, airlines operate in highly competitive markets and cannot easily pass rate increases on to customers.<sup>1</sup> They have continued to place pressure on airports to increase their efficiency. A set of performance measures would allow an airport to demonstrate any improvements. We also develop a linkage between the performance measure and management strategies arguing that it is not sufficient to simply describe performance but also to be able to assess it and understand how managers can affect their performance. The focus in this paper is upon air transportation infrastructure but we believe the approach has broad application.

In this paper we suggest that a method which can be used to assess the performance of the management of transportation infrastructure is Data Envelopment Analysis (DEA). We use airports as our context. Section 2 provides a brief overview of airport operations and issues to consider in developing performance measures. In section 3 we examine various approaches to efficiency measurement. Section 4 contains the description of the data and the Malmquist productivity index. The empirical results are reported and discussed in section 5 while the conclusions are contained in section 6.

---

<sup>1</sup> These figures are for North America. The costs in Europe and Asia are somewhat higher due to higher fees for navigation and airport rates and charges.

## 2. AIRPORT OPERATIONS AND ORGANIZATION

While all business enterprises, whether in the public or private sector, need to continuously monitor their performance, it is especially important in the airport industry due to the specific characteristics of airports. Doganis (1992) points out that in a competitive environment, market forces will ensure that optimal performance is equated with profitability. However, the conditions under which airports operate are far from competitive. Regulatory, geographical, economic, social and political constraints all hinder direct competition between airports. At the same time, the extent to which airports can attract other airports' traffic with different prices or service levels is also limited. In other words, the demand for airport services is likely to be relatively inelastic.<sup>2</sup>

The competitive environment of the aviation industry in North America and elsewhere means greater market mobility for carriers and freedom to establish linkages and alliances. Carriers enter and exit markets and change frequency of service and gauge of aircraft. They form partnerships, alliances and take equity positions in other national and global carriers. All of these factors have an impact upon airport demands and utilization. With all of the turmoil brought about by consolidation and restructuring of the air carrier industry and the desire to have an efficient aviation system (air carriers and airports) it seems reasonable that the impact of the domestic policy decisions or policies on efficient use of resources should be investigated.<sup>2</sup> Airports are subject to peak demands. To have perfectly satisfied customers (the airlines and their passengers) airports would need to supply sufficient runway and terminal capacity to avoid delays at even the busiest periods, allowing the airlines to maximize fleet utilization and improve load factors by providing service when their customers, the passengers, most desire. Airports, conversely, would like the airlines to spread their flight over the entire day so as to minimize runway and terminal requirements. The advent of hubbing has exacerbated this dichotomy with its concentration of arrivals and departures in narrow time bands. Even at those airports that are not used as hubs by any airline, aircraft movements are not evenly distributed. Among the other factors listed by Ashford (1984) that affect an airport's peaking characteristics is the domestic/international traffic mix as well as the long haul/short haul mix.

Doganis (1992) gives an interesting illustration of the pressures being brought to bear on runway capacity. Between 1971 and 1982, a period in which the average annual increase in the number of passengers was 5.2 per cent, all of the growth was accommodated by higher load factors (33%) and increased aircraft size (67%) with the number of departures remaining unchanged. Between 1982 and 1986, however, when the annual average growth rate rose to 8.8%, the increase in demand was met almost entirely (97%) by increasing the number of departures.

While airports should be asked to adhere to private financial standards, they must also be judged in the context of their overall goals. These can be "diverse, often not clearly articulated, and frequently specified (or influenced) less by professional managers than by public policy and political considerations within various sponsoring governments" (U.S. DOT, 1987). In the case of airports, it has been argued, federal support has resulted in facilities that are not so much what is needed as what the government is willing to pay for (Wells, 1992). Bhargava et al. (1993) found little in the way of "goal/objectives as a criterion" in much of the work he reviewed, finding instead the assumption that "financial measures appropriately capture the

---

<sup>2</sup> Even as "mere" landlords, however, the business of airport planning and management is extremely challenging. As Doganis (1992) points out: "Airport authorities must invest substantial capital sums in large and immovable assets that have no alternative use, to satisfy a demand over which they have little control except indirectly. It is the airlines and not the airports who decide where and how the demand for air travel or air freight will be met. Airports merely provide a facility for bring together airlines and their potential customers. Thus, matching the provision of airport capacity with the demand while achieving and maintaining airport profitability and an adequate level of customer satisfaction is a difficult task. It is made particularly difficult because investments to expand airport capacity are lumpy, increasing effective capacity by much more than is needed in the short term, and because they must be planned long in advance."

objectives of the firm.” Given the unique position of airports, profit measures are an inadequate, if not totally misleading means of assessing management performance.

Airports face many of the same problems of any public utility in which capital is lumpy and marginal operating costs low. For a manufacturing firm at a constant level of production, a slowdown in sales would be reflected as an increase in inventory and not a decrease in efficiency. If the slowdown were to be anticipated and production reduced, the amount of inputs consumed would likewise be reduced leaving the output/input ratio (i.e., productivity) unchanged (ignoring possible economies of scale). With most airports, however, the factors of production (inputs) usually do not change year to year and there can be no inventory of production. Efficiency, therefore, will suffer anytime there is a slowdown in the economy or by the airlines utilizing the airport, regardless of airport management ability or efforts.<sup>3</sup>

Since such exogenous factors do exist, how does one account internally for a change in output? If output is down, does this mean anything under the airport's control has become less productive? This exogenous slowdown needs to be accounted for in order to provide an accurate measure of managerial performance. In essence we want to determine how much variation in airport performance can be attributed to managerial decision-making and initiatives and what are the important decisions or strategies within that portion of airport performance an airport manager can affect.

### 3. PRODUCTIVITY AND EFFICIENCY

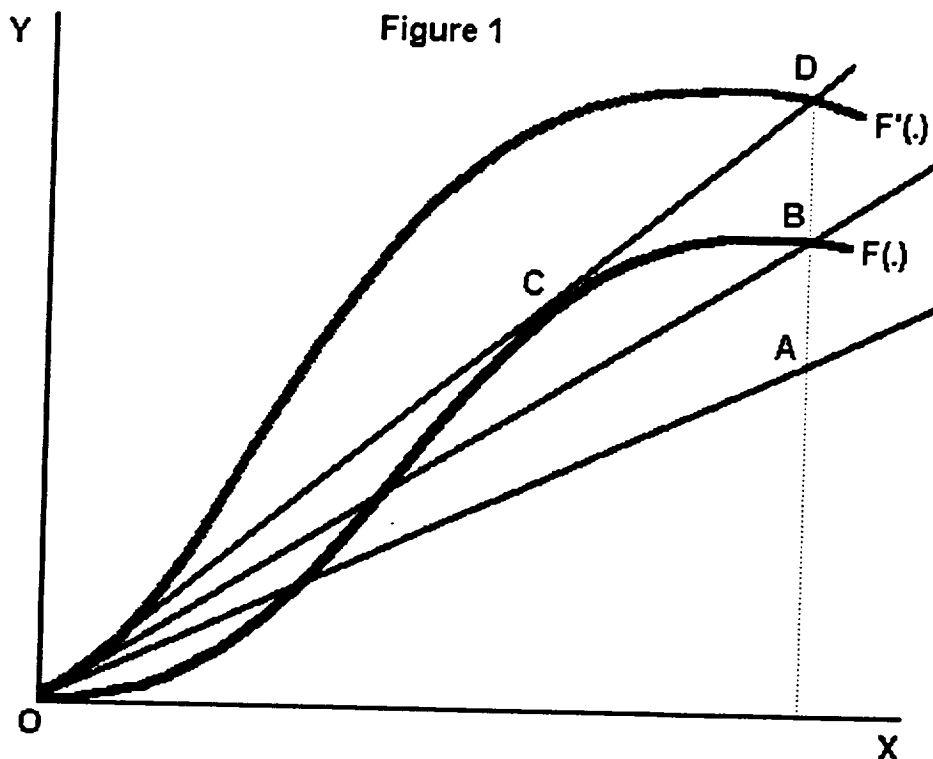
Productivity and efficiency mean different things to different people and in some instances are interpreted as being synonymous. Though the concepts are related, in general, productivity can be thought of as being a broader concept than efficiency. Both concepts can be related to a production function which is the primitive (in the single output case) representing the transformation of inputs to output. From a conceptual viewpoint, productivity and efficiency measurement can be classified into the frontier and non-frontier approaches and from an implementation viewpoint, into parametric and non-parametric. These are discussed below.

Consider the simple case of one output, one fixed factor of production – capital and one variable factor of production – labour. A measure of partial productivity could be labour productivity, which is output per unit of labour input, or, the average product of labour. An increase in the average product of labour would represent an increase in productivity however, as discussed below, this could come from a variety of sources.

Figure 1 illustrates a production function  $F(\cdot)$ : output is measured on the vertical axis and input on the horizontal axis. Consider a firm operating at the point A. This firm is operating at a point below the production function. Its productivity is nothing but the slope of the ray through the origin OA. Some researchers interpret the production function as a *frontier*, which represents the best practice. Though all firms may have access to the same technology, some may be better at using the technology than others. Firms that operate on the production function are obviously more efficient than those that do not. Thus, a firm operating at the point B is more efficient than one operating at point A. Moving from A to B increases productivity, but this increase is coming from *catch-up* or reducing *technical inefficiency*. Similarly, there could be another firm operating at point C. This firm is technically efficient just like the firm B, but it is utilizing the optimal scale of production and therefore has higher productivity than B, but the source of the higher productivity in this case is *economies of scale*. Thus what Figure 1 shows us is that productivity improvements can have different sources.

---

<sup>3</sup> A graphic example, though atypical in magnitude, is Anchorage International which has seen its concession revenue shrink from \$19.5 million in 1990 to \$5.4 million in 1993 due to the severe reduction in layovers and technical stops of aircraft flying between the U.S. and Japan. Another example is Dayton International, where passenger traffic has been cut in half between the time of the USAir merger with Piedmont Aviation on August 5, 1989 and the final closure of their Dayton hub in January of 1992.



Now consider the addition of another production function to Figure 1. The new production function,  $F'(\cdot)$ , lies above the old one. This represents *innovation, technical change* or *technical progress*. The production function is also sometimes interpreted as a *stochastic frontier*, which moves out over time due to advances in technology. Thus, firm B could move to new position D, doing so will increase productivity, but the source of the productivity improvement is not a reduction in technical inefficiency or as a result of exploiting scale economies, but due to technical change or innovation. Conventional or *non-frontier* approaches to productivity measurement ignore technical efficiency. These measures assume either that all firms are on the frontier or that their distance from the frontier does not change over time.

From an implementation viewpoint, methods of measuring efficiency can be broadly classified into non-parametric and parametric. Non-parametric methods include indexes of partial and total factor productivity, and data envelopment analysis. The latter is essentially a linear programming based method. Parametric methods involve the estimation of neoclassical and stochastic cost and or production functions.

The data requirements for the various methods differ, as do their ability to inform managerial decisions. The use of partial productivity measures is pervasive and though these measures are easy to understand and compute, they can be quite misleading, because they do not reflect differences in factor prices nor do they take account of differences in the other factors used in production. Partial productivity measures are also unable to handle multiple outputs.

One solution to some of these problems is to construct a Törnqvist index of total factor productivity (TFP). This measure does not suffer from the shortcomings of partial productivity measure, but taken alone it is not very informative for evaluating management strategies. Extracting more information from measures of total factor productivity typically requires reliance on estimating parametric neoclassical cost or production functions.<sup>4</sup> The data requirements are more onerous than partial

<sup>4</sup> These have their own problems. For example, though in theory all flexible functional forms can approximate an unknown production technology, in practice, results may differ quite substantially. Thus choice of functional form becomes an important issue. In addition, flexibility has a price, that is, violation of theoretical consistency requirements for cost minimization. Stochastic or frontier cost

measures. In addition to data on physical inputs and outputs, this measure also requires information on prices, which is used to aggregate inputs and outputs.

Data Envelopment Analysis (DEA) is a frontier method and an alternative that has found favor in applications where the behavioural objective is neither cost minimization, nor profit maximization, or where outputs are not easily or clearly defined; for example in measuring efficiency in schools, hospitals or government institutions. It is also useful in determining the efficiency of firms that consume or produce inputs or outputs, which lack natural prices. DEA is a [linear] programming based technique and the basic model only requires information on inputs and outputs.<sup>5</sup> DEA can incorporate multiple outputs and inputs; in fact, inputs and outputs can be defined in a very general manner without getting into problems of aggregation.<sup>6</sup> If more of a measure is desirable it can be modeled as output and if less of something is better, it can be interpreted as input. This is an attractive feature as in many service industries such as banking, it is difficult to determine whether deposits, for example, are an output or an input which produces loans. DEA can also make use of proxy outputs including output combinations that would not be used with other efficiency measures.<sup>7</sup>

DEA provides a scalar measure of relative efficiency by comparing the efficiency achieved by a decision-making unit (DMU) with the efficiency obtained by similar DMUs. The method allows us to obtain a well-defined relation between outputs and inputs. In the case of a single output this relation corresponds to a production function in which the output is maximal for the indicated inputs. In the more general case of multiple outputs this relation can be defined as an efficient production possibility surface or frontier. As this production possibility surface or frontier is derived from empirical observations, it measures the relative efficiency of DMUs that can be obtained with the existing technology or management strategy. Technological or managerial change can be evaluated by considering each set of values for different time periods for the same DMU as separate entities (each set of values as a different DMU). If there is a significant change in technology or management strategies this will be reflected in a change in the production possibility surface.<sup>8</sup> This paper uses the Malmquist index of productivity change, which is then decomposed into various components such as scale efficiency change and technical efficiency change. This is a DEA based method and allows us to take advantage of the fact that we have a panel data set.<sup>9</sup>

#### 4. THE MALMQUIST PRODUCTIVITY INDEX

Following Färe (1994a), we begin by defining the production technology  $T$  in any given time period.  $T$  is the set of all feasible input-output vectors,  $x$  is an  $N$  dimensional vector of inputs and  $y$  is an  $M$  dimensional vector of outputs.

$$T = \{(x, y) : x \text{ can produce } y\} \quad (1)$$

Based on certain axioms [Shephard (1970), Färe (1988)] one can define an output distance function which is a multi-output generalization of what in the single output case would be the ratio of actual to potential output. Thus if the production point is on the frontier, this ratio equals unity. The distance

---

and production functions suffer from the same shortcomings though unlike neoclassical functions, they are able to distinguish technical progress (movement in the frontier) from technical inefficiency (distance from the frontier).

<sup>5</sup> If factor price data are available, DEA can be used to analyze cost efficiency. Firms may be technically efficient but cost inefficient.

<sup>6</sup> All productivity measures have the shortcoming that they do not directly include user-borne costs. Using proxies can include these.

<sup>7</sup> For example, gross-ton-miles and car-miles or gross-ton-miles and revenues as alternative measures of outputs in the rail industry.

<sup>8</sup> For theory and applications of DEA see Charnes et al. (1994a)

<sup>9</sup> Traditionally, panel data have been handled in DEA via window analysis. Though this provides some indication of changes in efficiency over time, the choice of window width is arbitrary. For an application to the carbonated beverage industry see Eechambadi (1985) and Charnes et al. (1994b).

function is the reciprocal of the Farrell output-oriented measure of efficiency, which can be calculated using DEA.

$$D(x, y) = \inf \{ \theta : \{x, y / \theta\} \in T \} \quad (2)$$

Caves, Christensen and Diewert (1982) define the Malmquist productivity index with reference to the technology in time period  $t$  as:

$$M_t = \frac{D_t(x_{t+1}, y_{t+1})}{D_t(x_t, y_t)} \quad (3)$$

A similar measure could be defined using period  $t+1$  as the base. To avoid arbitrariness in the choice of base period, Färe et al. (1994a,b) propose using the geometric mean of the indexes for the periods  $t$  and  $t+1$  which yields the following Malmquist index of productivity change:

$$M_{t,t+1} = \left[ \frac{D_t(x_{t+1}, y_{t+1})}{D_t(x_t, y_t)} \right]^{1/2} \left[ \frac{D_{t+1}(x_{t+1}, y_{t+1})}{D_{t+1}(x_t, y_t)} \right]^{1/2} \quad (4)$$

Färe et al. (1994a,b) show that the above measure can also be expressed as:

$$M_{t,t+1} = \frac{D_{t+1}(x_{t+1}, y_{t+1})}{D_t(x_t, y_t)} * \left[ \frac{D_t(x_{t+1}, y_{t+1})}{D_{t+1}(x_{t+1}, y_{t+1})} \right]^{1/2} \left[ \frac{D_t(x_t, y_t)}{D_{t+1}(x_t, y_t)} \right]^{1/2} \quad (5)$$

In the above equation, the first term measures efficiency change and the second term (in square brackets) measures technical change. Calculating Malmquist index and its components requires the calculation of four distances:  $D_t(x_t, y_t)$ ,  $D_{t+1}(x_{t+1}, y_{t+1})$ ,  $D_t(x_{t+1}, y_{t+1})$  and  $D_{t+1}(x_t, y_t)$ . This is accomplished by solving four (constant returns to scale) linear programming problems, thus making use of the fact that output distance function is the inverse of the Farrell output oriented measure of technical efficiency. For each firm  $k$ ,  $D_t(x_t, y_t)$  can be computed as follows, as can  $D_{t+1}(x_{t+1}, y_{t+1})$  by substituting  $t+1$  for  $t$ :

$$((D_t(x_t, y_t)))^{-1} = \max_{\theta_k, \lambda_k} \theta_k$$

s.t.

$$\theta_k y_{t,m}^k \leq \sum_{k=1}^K \lambda_{k,t} y_{t,m}^k \quad m = 1, \dots, M \quad (6)$$

$$\sum_{k=1}^K \lambda_{k,t} x_{t,n}^k \leq x_{t,n}^k \quad n = 1, \dots, N$$

$$\lambda_{k,t} \geq 0 \quad k = 1, \dots, K$$

Similarly,  $D_t(x_{t+1}, y_{t+1})$  can be computed as follows, as can  $D_{t+1}(x_t, y_t)$  by interchanging  $t+1$  and  $t$ :



$$\begin{aligned}
((D_t(x_{t+1}, y_{t+1}))^{-1} &= \max_{\theta_k, \lambda_k} \theta_k \\
\text{s.t.} \\
\theta_k y_{t+1, m}^k &\leq \sum_{k=1}^K \lambda_{k, t} y_{t, m}^k \quad m = 1, \dots, M \\
\sum_{k=1}^K \lambda_{k, t} x_{t, n}^k &\leq x_{t+1, n}^k \quad n = 1, \dots, N \\
\lambda_{k, t} &\geq 0 \quad k = 1, \dots, K
\end{aligned} \tag{7}$$

Both the efficiency change and technical change measures in (5) can be decomposed further [Färe, Grosskopf and Roos (1996), Färe and Grosskopf (1998)]. They define the output oriented measure of scale efficiency as the ratio of an output oriented distance function for a variable returns to scale technology to that for a constant returns to scale technology or:

$$S_t(x_t, y_t) = \frac{D_t(x_t, y_t|V)}{D_t(x_t, y_t|C)} \tag{8}$$

Calculating this requires solving the LP in (6) with the following additional restriction for variable returns to scale:

$$\sum_{k=1}^K \lambda_{k, t} = 1 \tag{9}$$

Thus, the efficiency change component in (5) can be decomposed into scale efficiency change and pure efficiency change as:

$$EFFCH = \frac{S_t(x_t, y_t)}{S_{t+1}(x_{t+1}, y_{t+1})} \frac{D_{t+1}(x_{t+1}, y_{t+1}|V)}{D_t(x_t, y_t|V)} \tag{10}$$

The technical change component in (5) can also be decomposed as the product of the magnitude of technical change and (input and output) bias, where magnitude is defined as follows:<sup>10</sup>

$$MTECH = \frac{D_t(x_t, y_t)}{D_{t+1}(x_{t+1}, y_{t+1})} \tag{11}$$

To summarize, the Malmquist index of productivity change can be represented as the product of efficiency change and technical change. Efficiency change can be further decomposed as the sum product of scale efficiency change and pure efficiency change, whereas technical change can be decomposed as the sum product of the change in the magnitude of technical change and bias.

## 5. DATA AND RESULTS

Our data set is composed of information from 22 of the top 30 airports in the United States for the period 1989-1993. There are 110 observations organized in a panel. We recognize that an airport is an integration of airside facilities (runways, taxiways, apron's etc.) and terminal facilities that provide the linkage to the airside. However, there is no reason why each sub-production process of the 'airport production function' should exhibit the same levels or growth in productivity. Indeed if one examines the unit operating costs of movements (AC per movement) it appears there are relatively constant returns to scale but capacity utilization economies while if one examines unit operating costs of passengers (AC per passenger) there are apparent increasing returns to density; that

<sup>10</sup> The decomposition of technical change is also discussed in Grifell-Tatjé and Lovell (1997).

is, unit cost decreases with numbers of passengers served. The cost economies seem then to arise from the economies of large aircraft. As a final argument, a different set of management strategies apply to each of these two types of facilities. Airport managers have, one would expect, greater ease putting in place terminal strategies rather than movement strategies simply due to jurisdiction and property rights. There is also the interaction between airline strategies and airport productivity. In the past airports were perceived as 'public utilities' and their ability to affect their productivity was seen as being limited.

The models estimated define airports as a composite of producing two different but related services, these being terminal services and movements. Terminal services are modeled as having two outputs - number of passengers and pounds of cargo and six inputs - number of runways, number of gates, terminal area, number of employees, number of baggage collection belts and number of public parking spots. Movements have two outputs - air carrier movements and commuter movements and four inputs - airport area, number of runways, runway area and number of employees.<sup>11</sup> The results presented in Table 1 and Table 2 and illustrated in Figure and Figure are discussed below.

The results provide some interesting comparisons both within the products and across the products both within and across airports. For example, Boston [Logan Airport] exhibits a significant growth in productivity for movements with the majority of it coming from utilization of scale efficiency gains - improving the efficient use of existing resources with managing traffic, for example - while for terminals it exhibits relatively low productivity growth. In fact it appears that terminal utilization efficiency has diminished while there has been positive technical change. However, the relative values of efficiency are very different. Terminal efficiency was quite high at the beginning of the sample period while airside efficiency was relatively poor but improved markedly over five years. As is true of Salt Lake City but in most of cases the inefficiencies are moving in the same direction. The hub airports exhibit some loose similarities. It appears that as hubbing rises terminal efficiency improves but movements efficiency decreases most likely due to the feed from small commuter aircraft.

---

<sup>11</sup> We do not have disaggregated data on employees involved in the provision of terminal services and those involved in producing movements. In addition, we do not have data on fuel and other inputs such as materials.

**Table 1**  
**Terminals**  
(Average Annual Percentage Rate of Growth)

Terminals	1	2	3	4	5	6	7
	Malmquist	Efficiency	Scale	Pure	Technical	Magnitude	Bias <sup>12</sup>
	TFP	3+4	Efficiency	Efficiency	Change	of	
	2+5		y	y	6+7	Technical	
						Change	
Anchorage	3.5	4.3	4.3	0.0	-0.7	-0.5	-0.2
Atlanta	2.2	0.0	0.0	0.0	2.2	-0.2	2.4
Boston	0.7	-1.4	-0.4	-1.0	2.1	2.1	0.0
Baltimore/Washington	-3.3	-5.0	0.0	-5.0	1.8	1.7	0.1
Charlotte/Douglas	1.6	0.0	-0.9	0.9	1.6	0.8	0.7
Chicago Midway	-5.7	-5.7	-5.7	0.0	0.0	-0.3	0.3
Cincinnati/N. Kentucky	0.4	-2.4	0.0	-2.3	2.9	2.5	0.4
Cleveland Int'l	9.2	7.3	1.1	6.2	1.7	1.6	0.1
FT. Lauderdale	2.2	0.0	0.0	0.0	2.2	2.1	0.1
Kansas City	-7.7	-8.4	7.2	-14.5	0.8	1.5	-0.7
Memphis	1.7	0.0	0.0	0.0	1.7	-6.4	8.7
Milwaukee	-5.8	-8.9	-8.0	-1.0	3.4	4.7	-1.2
Minneapolis-St. Paul	4.8	2.3	0.0	2.3	2.4	2.3	0.0
Ontario	0.8	0.0	0.0	0.0	0.8	-6.6	8.0
Phoenix	-3.5	-1.1	-1.1	0.0	-2.4	-7.3	5.3
Portland	4.9	1.9	-0.1	2.0	2.9	2.9	0.0
St. Louis	-0.2	-2.5	-0.7	-1.8	2.4	2.4	0.0
Salt Lake City	5.9	3.5	-1.2	4.7	2.4	2.7	-0.3
San Diego	-0.3	0.0	0.0	0.0	-0.3	-3.3	3.1
San Francisco	1.3	0.0	0.0	0.0	1.3	1.2	0.1
San Jose	-12.8	-10.7	-0.1	-10.6	-2.3	-5.9	3.8
Seattle-Tacoma	0.4	-2.4	-2.4	0.0	2.8	-1.6	4.4
<b>All Airports</b>	<b>-0.1</b>	<b>-1.4</b>	<b>-0.4</b>	<b>-1.0</b>	<b>1.3</b>	<b>-0.2</b>	<b>1.5</b>

Note: We subtract 1 from the measures described in Section 4 and multiply by 100, to convert our results to average annual percentage rates of growth. The relationship between measures becomes additive rather than multiplicative.

<sup>12</sup> If the magnitude of technical change equals technical change, then (change in) bias is zero. When bias is zero, isoquants shift out in a parallel manner - technical change is neutral (joint neutral, both with respect to outputs and inputs). When technological change is biased (suppose input biased, so there is one output and 2 inputs - so we can only have input bias, then they (isoquants) will shift and twist at the same time. With multiple outputs and inputs we can have both input and output biases, the decomposition reported does not separate input and output biases. Biases could be the result of say reform programs.

**Table 2**  
**Movements**  
(Average Annual Percentage Rate of Growth)

Movements	1 Malmquist TFP 2+5	2 Efficiency 3+4	3 Scale Efficiency y	4 Pure Efficiency y	5 Technical Change 6+7	6 Magnitude of Technical Change	7 Bias
Anchorage	6.1	3.3	0.2	3.1	2.8	2.5	0.3
Atlanta	-0.6	0.0	0.0	0.0	-0.6	-3.3	2.8
Boston	14.2	10.5	6.3	3.9	3.4	1.8	1.6
Baltimore/Washington	-0.5	-2.8	1.7	-4.4	2.4	1.8	0.6
Charlotte/Douglas	-1.2	0.0	0.0	0.0	-1.2	-5.5	4.5
Chicago-Midway	-25.1	-21.9	-6.4	-16.5	-4.2	-5.9	1.8
Cincinnati/N. Kentucky	1.7	0.0	0.0	0.0	1.6	-2.2	3.9
Cleveland Int'l	2.3	2.4	-1.1	3.5	-0.1	-0.2	0.1
FT. Lauderdale	-15.0	-12.8	-1.5	-11.5	-2.5	-4.7	2.3
Kansas City	-10.3	-9.8	4.1	-13.3	-0.6	-1.3	0.7
Memphis	4.3	6.0	-0.1	6.0	-1.6	-3.3	1.7
Milwaukee	6.4	7.0	0.0	6.9	-0.6	-0.5	-0.1
Minneapolis-St. Paul	6.7	7.1	1.6	5.4	-0.4	1.1	-1.5
Ontario	0.6	4.0	2.0	1.9	-3.3	-3.3	0.0
Phoenix	0.4	0.0	0.0	0.0	0.4	-2.3	2.8
Portland	5.2	3.4	0.0	3.4	1.8	1.8	0.0
St. Louis	1.1	5.1	3.7	1.4	-3.8	-3.9	0.1
Salt Lake City	-1.6	0.8	0.6	0.2	-2.3	-3.5	1.3
San Diego	-0.6	0.0	0.0	0.0	-0.6	-6.9	6.7
San Francisco	0.0	-2.9	-1.3	-1.6	2.9	3.4	-0.5
San Jose	10.2	12.9	1.9	10.9	-2.4	-4.8	2.6
Seattle-Tacoma	0.2	0.0	0.0	0.0	0.2	-1.7	1.9
<b>All Airports</b>	<b>-0.1</b>	<b>0.3</b>	<b>0.5</b>	<b>-0.2</b>	<b>-0.4</b>	<b>-1.9</b>	<b>1.5</b>

Note: We subtract 1 from the measures described in Section 4 and multiply by 100, to convert our results to average annual percentage rates of growth. The relationship between measures becomes additive rather than multiplicative.

An examination of Figure 1 and Figure 2 illustrates the variation in productive efficiency among airports and the relative differences in airside and terminal efficiency both between and at the same airport. Terminals tend to be, on average, more efficient than airside - the index is near 1 for most terminals whereas the index for airside is less than 1 influenced mostly by the recession in 1990-91. Airports that are hubs (and not gateways) exhibit a significant decrease in productivity in both airside and terminals in 1990-91. In order to undertake a comparison of airport productivity Figure 3 through Figure 5 illustrate the Malmquist productivity indices for both the airside and terminal operations for each period 1989 through 1993.

Figure 2

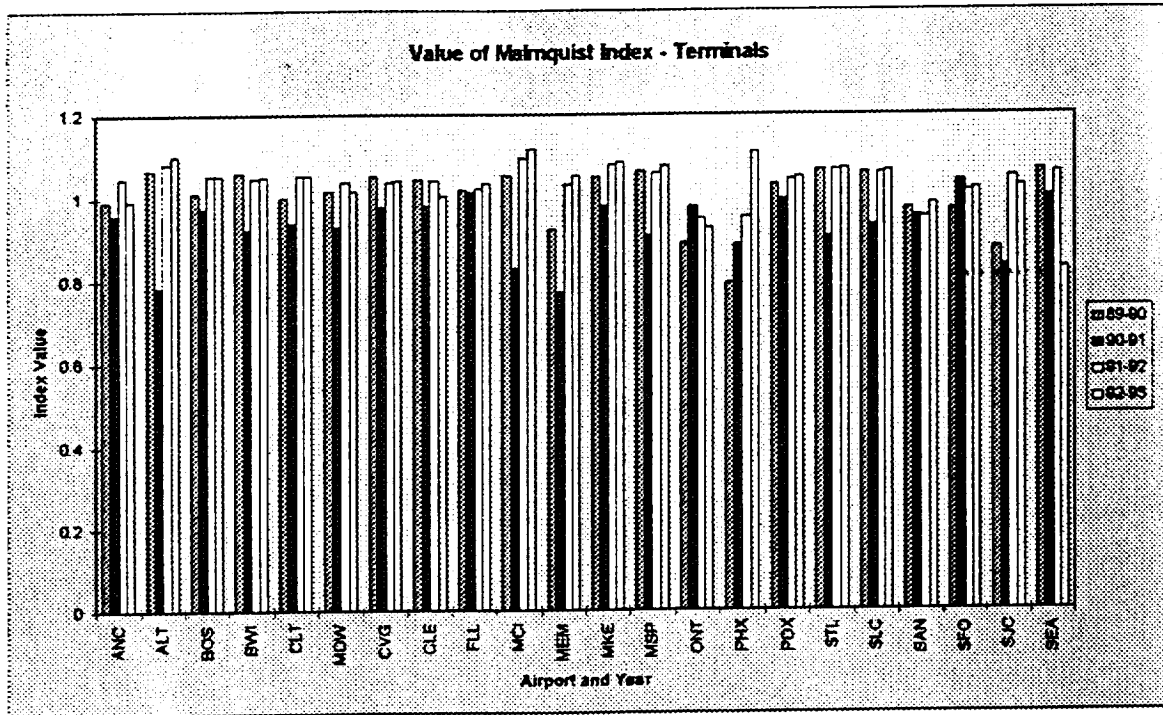
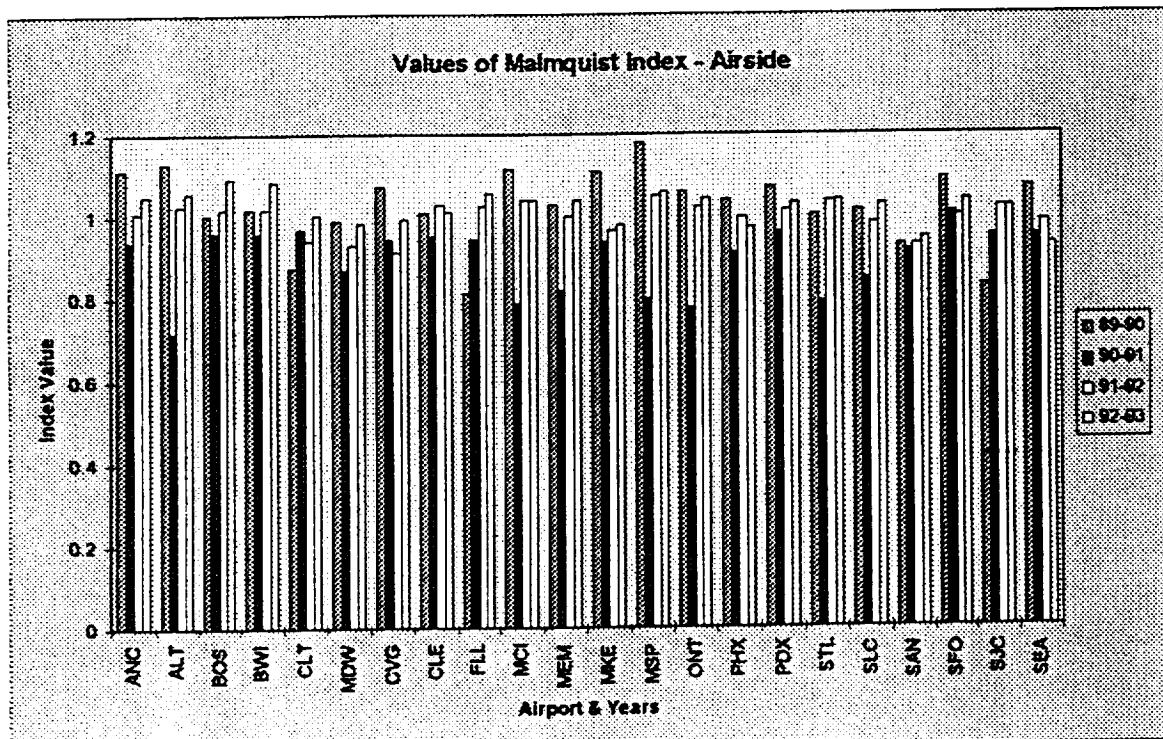
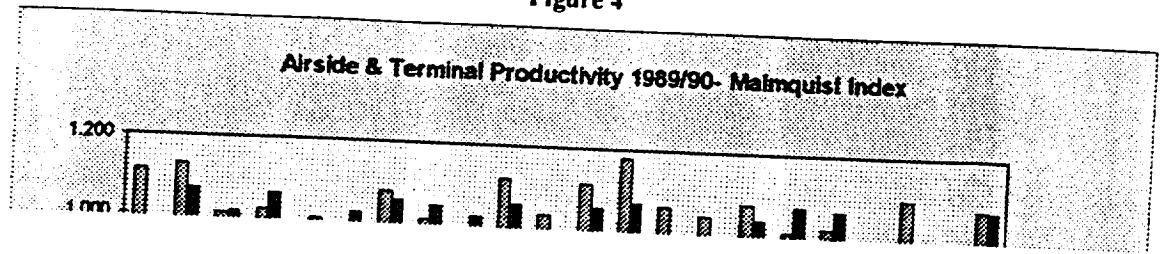


Figure 3



An examination of the four figures illustrates the large differences between airports and how lack of performance in one area can, in some cases, be offset by better performance in another. A number of airports, SEA, MDW, BOS, CLE, ATL, CVG, MCI, PDX, STL and SAN have high productivity for both the airside and terminals (see Figure ) while there do not appear to be airports that are 'equally' bad at airside and terminal productivity. Rather, the remaining airports exhibit relatively better performance in one area or another - see CLT, FLL, ONT and PHX in Figure . Phoenix, for example, has high airside productivity but low terminal productivity.

Figure 4



54-09

01/1042

385552

p. 14

# Access to airports: a case study for the San Francisco Bay Area<sup>1</sup>

First Draft

Eric Pels<sup>23</sup>, Peter Nijkamp, Piet Rietveld

Free University Amsterdam, Department of Regional Economics,

Boelelaan 1105, 1081 HV Amsterdam, Netherlands.

## Abstract

In this paper (nested) logit models that describe the combined access mode-airport-airline choice are estimated. Nested models with the choice sequence (1) airport-access mode combination and then (2) airline are preferred for Bay Area residents and visiting business travelers. For visiting leisure travelers, a multinomial logit model is preferred.

**Keywords:** airport choice, access modes, discrete choice models

---

<sup>1</sup> Preliminary version, comments welcome!

<sup>2</sup> Email: apels@econ.vu.nl. Fax: +31-20-4446004

<sup>3</sup> Also affiliated with the Tinbergen Institute, Keizersgracht 482, 1017 EG Amsterdam.

# 1 Introduction

Airports in a multiple airport region, where passengers (traveling to a fixed destination) are able to choose between different departure airports, will compete with substitute airports for origin (and also destination) passengers. Passengers take a number of decisions; they have to choose the (departure) airport, airline and airport access mode (given that they already have decided they will fly). These choices can be made simultaneously or sequentially. These choices depend on a number of variables such as airport taxes and airport access times, frequency of service offered by the airline and airfare, and availability and cost of the access mode. Moreover, these choices may be mutually dependent; depending on whether these choices are taken sequentially or simultaneously. The choice of airport access mode has been studied only sparsely in the literature; notable exceptions are Bondzio (1996) and Harvey (1986), who offer empirical studies of the passengers' choice of access mode in Germany and the San Francisco Bay Area respectively. Both authors use multinomial logit models with access time and cost as explanatory variables. Moreover, Bondzio (1996) also estimates nested logit models and finds that business travelers make the choices of access mode and airport sequentially while leisure travelers make the choice simultaneously; the access time to the airport (which is highly mode dependent) is concluded to be higher for business passengers than for leisure travelers.

In most studies on airport choice, the (aggregated) frequency is an explanatory variable, but the airline choice is considered as given. Pels et al. (1998) found that a nested model in which first an airport chosen and then an airline is statistically superior. In this paper we will analyze the choice of access mode in the San Francisco Bay Area in relation to the choice of airport and airline by means of a nested logit model. The results will then be compared to the results (for Germany) of Bondzio (1996) -in order to examine whether there are regional (international) differences in the determinants of access mode choice- and Harvey (1986), addressing the same problem using data for 1980 -in order to investigate whether the determinants of access mode choice have changed over time.



## 2 The econometric model

In this Section an econometric model for the joint access mode-airport-airline choice will be formulated. First, in Subsection 2.1, a concise review of some of the references already mentioned in the introduction will be offered, while next, based on the discussion of these studies, the econometric model will be formulated in Subsection 2.2.

### 2.1 Literature review

Air travelers have to make a number of decisions. Access mode, departure airport and airline are but some of the decisions to be made. These decisions are dependent on one another, and should be modeled as such.

Bondzio (1996) estimated nested logit models to explain the joint access mode-departure airport choice for German airports, using access time to the airport, access costs and frequency of service as explanatory variables. For business travelers, a nested model with the choice sequence (1) access mode and then (2) departure airport appeared to be the (statistically) preferred model. For leisure travelers, it was concluded that the nested structure which best replicated the behavior of business travelers did not add much compared to a multinomial logit model, which was therefore the preferred model specification.

Pels et al. (1998) found that a nested logit model with the choice sequence (1) airport, and then (2) airline best explained the joint airport-airline choice for both business and leisure travelers in the San Francisco Bay Area.

In both studies mentioned above, the nested structures were found to be superior to the conventional multinomial logit models. In case of the airport-airline choice, airlines operating from the same airport are closer substitutes than airlines operating from different airports. Hence the introduction of a new airline at a certain airport will affect the airlines already operating from that airport more than airlines operating from alternative airports. Likewise, if the train is the most preferred access mode, airports that can be reached by train are closer substitutes than airports that cannot be reached by train.

Based on the findings of the studies discussed concisely in this subsection, it is expected that a nested logit model would best explain the access mode-airport-airline choice. A corresponding model will be formulated in the next Subsection.

## 2.2 The econometric model

Suppose a traveler has decided to fly to a particular destination (airport). The traveler then has to choose an airline ( $l$ ), departure airport ( $d$ ) and airport access mode ( $a$ ). There are several alternative model specifications. The most simple one is the multinomial logit model where all combinations ( $l, d, a$ ) are treated as alternatives of which the derived utilities, by assumption, are independent. As a result, if one alternative is added, *all* other alternatives would suffer proportionally; thus if at airport  $d$  a new airline is introduced, all other alternatives (i.e. also at the alternative airports  $d'$ ) would suffer proportionally, whereas it would be more reasonable to assume alternatives including airport  $d$  would suffer more. To overcome this “independence of irrelevant alternatives” assumption, a nested multinomial logit model can be specified. Then one recognizes that there are clusters of alternatives of which the derived utilities are correlated. Utilities of alternatives from different classes are not correlated. Then the problem is to identify the different relevant clusters.

Let there be  $L$  airlines,  $D$  airports and  $A$  access modes. The alternatives made up by the airlines operating from the same airport and the airport can be seen as clusters of alternatives:  $L(d) \subset L$ ,  $d \in D$  (see Pels et al., 1998). Likewise, the alternatives constituted by the airports and the same access mode can be seen as clusters:  $D(a) \subset D$ ,  $a \in A$  (see Bondzio, 1996). The corresponding probability model is:

$$P(l, d, a) = P(a) P(d|a) P(l|d, a) \quad (1)$$

$$P(l|d, a) = \frac{\exp(\frac{V_l}{\mu})}{\sum_r \exp(\frac{V_r}{\mu})}, l \in L(d), d \in D(a), a \in A \quad (2)$$

$$P(d|a) = \frac{\exp\left(\frac{V_d + \mu \ln \sum_l \exp\left(\frac{V_l}{\mu}\right)}{\theta}\right)}{\sum_d \exp\left(\frac{V_d + \mu \ln \sum_l \exp\left(\frac{V_l}{\mu}\right)}{\theta}\right)}, d \in D(a), a \in A \quad (3)$$

$$P(a) = \frac{\exp\left(V_a + \theta \ln \sum_d \exp\left(V_d + \mu \ln \sum_l \exp\left(\frac{V_l}{\mu}\right)\right)\right)}{\sum_a \exp\left(V_a + \theta \ln \sum_d \exp\left(V_d + \mu \ln \sum_l \exp\left(\frac{V_l}{\mu}\right)\right)\right)}, a \in A \quad (4)$$

where  $V_l$  is the systematic utility derived from airline  $l$ ,  $V_d$  is the systematic utility derived from airport  $d$  and  $V_a$  is the systematic utility derived from access mode  $a$ . In this model, a passenger chooses an access mode based on characteristics of the access mode and the maximum expected utility of using the airports available when using the access mode. The passenger chooses an airport based on characteristics of the airport and the maximum expected utility of using the airlines available from the airport. In other words, the passenger first chooses the access mode, then the departure airport and then the airline. Alternatively, the passenger chooses the access mode and departure airport simultaneously and then chooses the airline:  $L(d,a) \subset L$ ,  $d,a \in D \times A$  and in the probability model  $\theta = 1$ .

Let the systematic utility of using an airline  $l$  be given by

$$V_l = \alpha_p p_l + \alpha_f \ln(f_l) + \alpha_s \ln(s_l) \quad (5)$$

where  $p_l$  is the airfare charged by airline  $l$ ;  $\alpha_p < 0$ .  $f_l$  is the frequency of service, included in logarithmic form, as it is an indication of the “size” of an airline in a market to a certain destination;  $\alpha_f > 0$ .  $s_l$  is the average number of seats, included in logarithmic form, as it is also an indication of the “size” of an airline<sup>4</sup>. Moreover, aircraft size can be seen as an indicator of the level of comfort; larger aircraft have more amenities. We use the average number of seats as a proxy for aircraft size. To account for decreasing marginal utility of comfort, it is in logarithmic form;  $\alpha_s > 0$ . The systematic utility of using an airport  $d$  is given by

<sup>4</sup> The “size” of an airline in an origin-destination market can be represented by  $S_l = f_l s_l$ .  $S_l$  is best included in logarithmic form in the utility function; see Ben-Akiva and Lerman (1987, chapter 9) for details.

$$V_a = \beta_a + \beta_d d_a \quad (6)$$

where  $\beta_a$  is an airport specific constant,  $d_a$  is the road distance to the airport;  $\beta_d < 0$ .

The systematic utility of using an access mode  $a$  is

$$V_a = \gamma_a + \gamma_p p_a + \gamma_t t_a + \gamma_c c \quad (7)$$

where  $\gamma_a$  is a mode specific constant,  $p_a$  is the cost of the access mode,  $\gamma_p < 0$ .  $t_a$  is the access time to the airport using access mode  $a$ ;  $\gamma_t < 0$  and  $c$  stands for personal characteristics (such as group size, pieces of luggage etc.).  $\mu < \theta < 1$ . When  $\mu = \theta = 1$ , the model reduces to the multinomial logit model.

### 3 The 1995 MTC Airline Passenger Survey

The 1995 Metropolitan Transportation Commission Airline Passenger was conducted in August and October 1995 at San Francisco International Airport (SFO), San Jose International Airport (SJC), Oakland International Airport (OAK) and Sonoma County Airport (STS). Some 21,500 passengers departing from these airports were interviewed within 45 minutes to 1 hour before take off; see Table 1 for the distribution of respondents over the airports.

*Table 1 Respondents and total enplaned passengers (1995)*

Airport	San Francisco	San Jose <sup>1</sup>	Oakland	Sonoma County	Total
Respondents	10,454	7,119	3,497	54	21,124
Passengers	15,013,265	4,267,071	7,750,857	<500,000	

1) A disproportionately large number of interviews was conducted at San Jose at the request of the airport authorities.

In Table 2 the distribution of respondents over the different access modes is given for each of the four airports. The majority of the passengers, both business and leisure, use a car to get to the airport. The percentage of private cars used by visiting passengers is quite high. This can only be the case if some (most) of these passengers are dropped

off (at the airport). This information is not available; the information that is available is the number of people that came into the terminal to see the respondent off. Hence one can only expect that more respondents (especially visitors) were dropped off at the airport and *not* accompanied into the terminal. This assumption is reinforced by the fact that a visiting business traveler is more likely to use a rental car than a private car, while for visiting leisure travelers the reverse holds true.

Compared to SJC, OAK and STS, passengers at SFO use more often the access modes that are alternatives to the car (though the car, whether private or rented, is by far the most likely access mode).

*Table 2a Shares of different access modes (%), SFO*

	residents			visitors		
	business	leisure	total <sup>1</sup>	business	leisure	total <sup>1</sup>
private car	67	61	64 (84)	14	31	24 (68)
rental car	3	2	2 (95)	40	29	34 (96)
private scheduled	6	9	8 (97)	7	7	7 (96)
public transit	1	2	2 (99)	1	2	1 (94)
door 2 door van	11	15	13 (98)	13	15	14 (97)
hotel courtesy	1	3	2 (97)	7	7	7 (98)
taxi	7	5	6 (97)	12	6	8 (97)
limousine	3	2	2 (95)	5	3	4 (97)

1) In brackets the % of respondents using a private car who were *not* accompanied by someone into the terminal to see the respondent off.

*Table 2b Shares of different access modes (%), SJC*

	residents			visitors		
	business	leisure	total <sup>1</sup>	business	leisure	total <sup>1</sup>
private car	87	88	88 (81)	24	66	43 (66)
rental car	3	1	2 (91)	61	25	46 (94)
private scheduled	1	2	1 (100)	2	2	2 (96)
public transit	0	1	1 (100)	0	1	1 (95)
door 2 door van	2	2	2 (99)	1	1	1 (97)
hotel courtesy	0	0	0 (100)	8	2	5 (98)
taxi	5	5	5 (91)	4	2	3 (97)
limousine	2	1	1 (95)	1	1	1 (81)

1) see footnote at Table 2a

*Table 2c Shares of different access modes (%), OAK*

	residents			visitors		
	business	leisure	total <sup>1</sup>	business	leisure	total <sup>1</sup>
private car	87	83	84 (79)	32	62	52 (57)
rental car	2	1	1 (96)	50	24	33 (93)
private scheduled	2	3	3 (98)	2	3	3 (92)
public transit	3	7	6 (99)	4	4	4 (90)
door 2 door van	3	4	4 (94)	5	3	3 (100)
hotel courtesy	0	0	0 (100)	2	1	2 (96)
taxi	2	1	1 (88)	4	2	3 (91)
limousine	1	0	1 (100)	0	0	0 (100)

1) see footnote at Table 2a

*Table 2d Shares of different access modes (%), STS*

	residents			visitors		
	business	leisure	total <sup>1</sup>	business	leisure	total <sup>1</sup>
private car	83	100	88 (89)	46	86	60 (50)
rental car	8	0	8 (50)	36	14	28 (100)
taxi	4	0	3 (100)	9	0	6 (100)
limousine	4	0	3 (100)	9	0	6 (0)

1) see comment made under Table 2a

All airports can be reached using public transportation, but whether public transportation is a likely access mode depends on the city of origin and the airport used. SFO, SJC and OAK can be reached by rail and bus from some cities, and only by bus from other cities. In the analysis, rail and bus are joined in the access mode public transportation; we assume public transportation is available to each passenger. In map 1 the airports, road system and points of origin for the respondents are given.

*map 1 about here*

#### 4 Estimation Results

To be able to estimate the model, data on travel times and costs for the different access modes are necessary. Using a road map of the San Francisco Bay Area<sup>5</sup>, access times using a private car could be calculated using the latitude and longitude of the point of origin and the airports in the system. Access times for the other modes were estimated as: access time for the private car + 15 minutes for taxi, door to door van and rental

<sup>5</sup> Downloadable from [www.bts.gov](http://www.bts.gov)

car and twice the access time using a private car for public transportation. For hotel courtesy the same access time as for the private car was used. As the information on whether a respondent using a private car was dropped off or used a (longer term) parking lot was incomplete, the cost of using a private car was fixed at the cost of a 24 hour parking period. It is noted that for some respondents this may be too high while it is too low for others. Based on the price information found on different websites of car rental companies, the cost of using a rental car was set at \$50. For the modes taxi, door to door van and public transportation average costs could be found on the web for some city-airport pairs. Based on these data, average access costs per mile could be calculated. These were \$2.50 per mile for a taxi, \$1.10 per mile for a door to door van and \$1 base + \$0.05 per mile for public transportation. Hotel courtesy was assumed free of charge.

The model as specified in equations (1)-(7) was estimated using FIML. The full nested structure (with three levels) did not deliver viable results. Moreover, the statistically preferred model for the joint access mode-airport choice (using the aggregated frequency and number of seats as explanatory variables for the airport choice) was a multinomial logit model. Hence the model was restated such that the passenger first chooses an access mode-airport combination and then an airline.

Estimation results for Bay Area residents are presented in Table 3. The available access modes are: private car, rental car, door to door van (including private scheduled)<sup>6</sup>, public transportation and taxi (including limousine). In Table 3 rental car is a dummy variable which takes the value 1 if the respondent has chosen a rental car and has used it for other purposes besides driving to the airport. Home is a dummy variable which takes on the value 1 if the respondent's origin was his/her home. As this variable has the same values across all mode-airport combinations, the parameter for the mode private car was normalized to 0. To avoid multi-collinearity (with the rental car dummy) the parameter for the mode rental car was also fixed at 0. The parameter  $\mu$  describing the heterogeneity between airlines is made airport specific;  $0 \leq \mu < 1$ . Airlines are closer substitutes if  $\mu$  is closer to 0.

---

<sup>6</sup> Private scheduled and door to door van are treated as the same access mode, although preferable they should be treated as different access modes. However, for technical reasons and because the average costs found on the web were in a number of cases given for private scheduled and door to door van together, they were treated as the same.

Table 3 Estimation results, Bay Area residents, August 1995

Parameter	Business travelers		Leisure travelers	
	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error
ln(frequency)	0.85131	0.83694E-01	0.638582	0.67999E-01
ln(seats)	1.4555	0.36331	1.6626	0.28511
constant	SFO	reference		reference
	SJC	1.0215	1.0274	0.16321
	OAK	1.4017	1.9070	0.91340E-01
access cost	-0.38181E-01	0.53941E-02	-0.23268E-01	0.44933E-02
access time	-0.88490E-02	0.20696E-02	-0.14344E-01	0.16538E-02
rental car	4.6546	1.1512	4.2217	1.2208
home car		reference		reference
	d2d <sup>1</sup>	1.6569	1.6352	0.21016
	pt <sup>2</sup>	-0.67739	-0.33338	0.20788
	taxi	2.1498	1.2405	0.42649
$\mu_{SFO}$	0.37446	0.87101E-01	0.47049	0.75418E-01
$\mu_{SJC}$	0.19857	0.79549E-01	0.36100	0.70909E-01
$\mu_{OAK}$	0.19797	0.79952E-01	0.32423	0.69882E-01
Log-likelihood		-1864.406		-3145.597
$\rho^2$		0.46		0.43
observations		794		1278

- 1) door to door van  
2) public transportation

From Table 3 it appears that business travelers are more sensitive to frequency, but are less sensitive to access time and access cost than leisure travelers. The latter finding seems to contradict the common finding in the literature that business passengers are more sensitive to access times than leisure travelers. In the "business model" the alternatives within the clusters (clusters constituted of airlines and the same airport-access mode combination) are closer substitutes than in the leisure model. Moreover, the alternatives within the clusters not including SFO seem to be closer substitutes than the alternatives within the clusters including SFO. When a passenger will use a rental car also for other reasons than going to the airport, the rental car is more likely to be chosen as the access mode. When leaving from home, business travelers are more likely to choose a taxi than leisure travelers would. Public transportation is a less likely access mode when leaving home. Given the access times



(and the maximum expected utilities of the airlines operating from the airports), passengers seem to prefer SJC and OAK over SFO.

Estimations for Bay Area visitors are presented in Table 4. The available access modes are: rental car, door to door van, public transportation, taxi and hotel courtesy. For the leisure travelers, the nested structure was rejected: the  $\mu$ 's were larger than 1 and therefore theoretically not valid. Hence for the visiting leisure travelers a multinomial logit model is preferred. Models including both the access time and access cost led to theoretically invalid results: the sign for the access cost took on the wrong value. Hence the estimation results for models with only the access time parameter are presented.

<i>Table 4 Estimation results, Bay Area visitors, August 1995</i>				
Business travelers			Leisure travelers	
Parameter	Parameter	Standard Error	Parameter	Standard Error
	Estimate		Estimate	
ln(frequency)	0.83488	0.93899E-01	1.2694	0.98588E-01
ln(seats)	1.2276	0.46122	1.9627	0.40400
constant	SFO	reference		reference
	SJC	0.77813	1.4608	0.18818
	OAK	0.73498	0.88862	0.13066
access time	-0.16871E-01	0.19857E-02	-0.46228E-01	0.27616E-02
hotel	hotel <sup>1</sup>	reference		reference
	rent <sup>2</sup>	0.86428	1.3923	0.18354
	d2d <sup>3</sup>	-0.61566	1.3169	0.26878
	pt <sup>3</sup>	0.35715	0.65484	0.32571
	taxi	1.6708	0.50547	0.14175
$\mu_{SFO}$	0.29157	0.81419E-01		-
$\mu_{SJC}$	0.13424	0.70440E-01		-
$\mu_{OAK}$	0.13363	0.71660E-01		-
Log-likelihood		-2049.64		-1579.871
$\rho^2$		0.42		0.44
observations		813		656

1) hotel courtesy  
2) rental car  
3) door to door van  
4) public transportation

The parameters for the frequency and seats in the business model do not differ that much from the business model for the residents: the estimates fall within each other's 95% confidence interval. Like in the model for the residents, the alternatives within the clusters not including SFO seem to be closer substitutes than the alternatives within the

clusters including SFO. For the leisure travelers, a multinomial logit model is preferred, in which there are no clusters and no perfect substitutes. Because of the different model structures, the parameters are difficult to compare.

## 5 Conclusion

In this paper discrete choice models describing the access mode-airport-airline choice were estimated. In a simplified model describing the access mode-airport choice the nested structure first airport, then airline, which Bondzio (1996) found to be the preferred model for business passengers in Germany, was rejected in favour of a multinomial logit model. Hence the model describing the access mode-airport-airline choice has two levels. First the access mode and airport are chosen simultaneously, based on access mode and airport characteristics and the maximum expected utility from the airlines available from each access mode-airport combination. Next, the airline is chosen. This structure was statistically preferable to the multinomial logit model for both resident business and leisure travelers. For resident passengers (both business and leisure), access times and access costs were significant in the access mode-airport choice. For visiting passengers (both leisure and business) on the other hand, models with the access time were preferred.

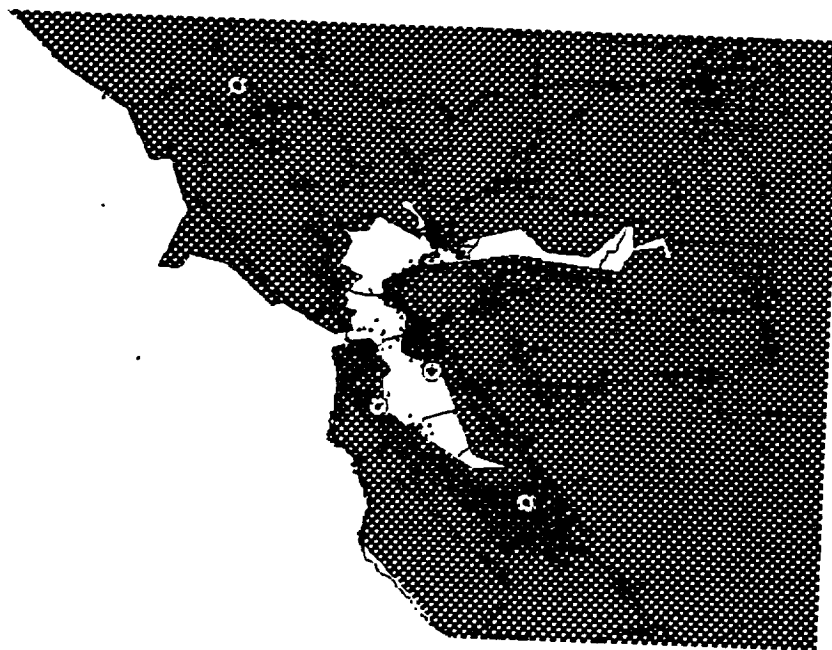
An interesting finding is that the alternatives (airlines) available from the clusters including Oakland International Airport or San Jose International Airport are closer substitutes than the alternatives available from San Francisco International Airport. This may be due to the fact that, in general, there are more airlines available to a given destination than from the other three airports.

The following research agenda follows from this paper. First and foremost, more research has to be done to be able to derive more reliable access times and costs. Second, airfares should be included in the analysis.

## References

- Ben-Akiva, M. and S.R. Lerman (1987), *Discrete Choice Analysis: Theory and Application to Travel Demand*, Cambridge, Mass., MIT Press.
- Bondzio, L. (1996), *Modelle fuer den Zugang von Passagieren zu Flughaeften* (Models for the Passengers' Access to Airports), Ph.D. thesis, Ruhr-University Bochum (in German).
- Harvey, G. (1987), Airport Choice in a Multiple Airport Region, *Transportation Research*, 21A(6), 439-449.
- Ndoh, N.N., D.E. Pitfield and R.E. Caves (1990), Air Transportation Passenger Route Choice: A Nested Multinomial Logit Analysis, *Spatial Choices and Processes*, eds Fischer, M.M., P. Nijkamp and Y.Y. Papageorgiou, 349-365, Elsevier Science Publishers, North-Holland.
- Pels, E., P. Nijkamp and P. Rietveld (1997), Substitution and Complementarity in Aviation: Airports vs Airlines, *Transportation Research*, 33E, 275-286.
- Pels, E., P. Nijkamp and P. Rietveld (1998), *Airport choice in a multiple airport region: a case study for the San Francisco Bay Area*, Free University Amsterdam, mimeo.

*Map 1 The Bay Area Road System, Locations of Airports and Respondents.*



55-09  
04/24/83  
385553

## **INTEGRATED AIRPORT PAVEMENT MANAGEMENT AND FACILITY MANAGEMENT USING GEOGRAPHICAL INFORMATION SYSTEMS TECHNOLOGY**

By Michael T. McNerney  
Director, Aviation Research Center  
The University of Texas at Austin  
3208 Red River, Suite 200  
Austin, Texas USA 78705

### **INTRODUCTION**

The premise of this paper is that the antiquated methods of managing airport pavements and facilities must be discarded and that new, innovative methods of integrating information between departments could be implemented to more effectively manage the airport as a system. These better methods will result in both cost savings from better management, as well as in operational savings to the users of the airports. These methods will also provide airport managers with the tools to better plan and manage the facilities with respect to the true cost of ownership. Geographical Information Systems and precise satellite positioning systems are the integrating technology to accomplish this task.

This paper also recommends that the 1970s Pavement Condition Index method adopted by the Federal Aviation Administration for airport pavement management not be used for airports with significant commercial service. GIS provides a far better method to geographically track distresses and other data, and can provide much better tools for evaluating and predicting pavement performance. This paper also recommends that precise positioning be used with differential Global Positioning System (D-GPS) to collect the locations of several pavement attributes for spatial analyses.

Finally this paper describes an ideal airport pavement management system and an Enhanced Pavement Management System (EPMS) that factors into maintenance strategies the true costs associated with user delays for various sections of pavement.

### **WHAT IS GIS?**

Geographical Information Systems are computer systems that provide functionality to collect, manage, display and analyze geospatially-referenced data and its related attribute data. Computer-aided-Drafting (CAD) provides graphical drawings of objects in 2 or 3 dimensional reference space. CAD can also be augmented in what is

often termed "Smart-CAD", to attach relational database links to drawing objects permitting one to extract stored information on the object. However, GIS takes Smart-CAD one step further by providing the capability to analyze objects relative to their geo-referenced locations in space and to other objects. Spatial analysis provides the ability to analyze which objects (e.g. dwellings) lie within any specified or calculated distance of any other object (e.g. underground utility feature).

## GIS SURVEY

In 1994, 1995 and 1997, surveys were mailed to airports certified for air carrier or air taxi operations in the United States to determine if GIS, for any number of applications, were in use or was planned for use within the next three years. The details of the first survey were reported in a conference sponsored by the Urban and Regional Information Systems Association, and are available on the World Wide Web.<sup>1</sup> In each of three surveys, the majority of airports which returned surveys either had plans to use GIS within three years or were actually using GIS for one or more applications. Each of airports reported approximately the same proportion of GIS use as shown in Figure 1.

The survey also ascertained the number and types of applications actually used and planned for use at each of the airports. Generally, applications primarily fell into two main categories. Applications related to environmental analysis, management or compliance, such as noise and clean water issues, or they related to infrastructure or facility management. The surveys and selected interviews revealed that in most cases GIS implementation is based upon a funded need for a specific application, such as noise mitigation, which requires managing 5000 properties or the installation of a noise monitoring system. Other implementations of GIS driven by specific applications included underground utility surveys, pavement management surveys and management of lease space.

The conclusions reached from the surveys were that most airports are either using or planning for use GIS within three years. The survey also revealed tremendous demand for the growth of airport GIS, that airports with GIS all have plans to add more applications and that there is need for education and cooperation among airports relative to GIS technologies.

---

<sup>1</sup> McNerney, M. T., "The Use of Geographical Information Systems at U.S. Airports," Proceedings, 1994 Annual Conference of the Urban & Regional Information Systems Association, August 1994, copy available at <http://www.utexas.edu/research/ctr/aviation>.

The major premise behind MicroPAVER is that the decline in PCI (100 points minus total deduction points) indicates over time the need for maintenance, repair and rehabilitation. If MicroPAVER or the PCI is used to predict remaining life, major problems can be overlooked and extremely poor predictions are possible. At major hub airports where runway utilization is critical and aircraft delay due to congestion is measurable, MicroPAVER as a management tool will end up costing far more money than it saves.

There are several potential failure modes of airfield pavements that the PCI does not address because it is only a surface distress measurement. Failures due to the deterioration of the subsurface materials, failure due to surface profile, or failure due to fatigue of concrete are not adequately addressed in the PCI method. Structural behavior of the pavement to load is not considered in the MicroPAVER analysis. Even the accumulation and distribution patterns of aircraft traffic are not even considered in a remaining life analysis using MicroPAVER, only a change in PCI relative to time.

There are technical limitations within the precise measuring method, such as repairing a small joint spall with a small patch, which results in increasing the total deductions on the pavement. Other technical limitations have been raised about combining multiple distresses, failure to record fatigue cracking less than 3mm in crack width, and high deductions for patching.

Pavement Condition Index essentially reduces all pavement sections to a single number. It essentially says that if a pavement drops below a certain number it is in need of rehabilitation. Pavement performance is not that simple, and decisions on a billion dollars of replacement cost should not be made on PCI simplifications.

## **IDEAL AIRPORT PAVEMENT MANAGEMENT SYSTEM**

The ideal pavement management system not only can analyze several different failure modes of airfield pavements, but also can track by geographical location all pavement discrepancies. If maintenance forces or a contractor installs a patch, the exact location is noted and the pertinent information to track the longevity of that patch is now captured for the life span of the facility. If a pattern develops of premature failure in one specific patching technique or material, the GIS has the data to analyze the problem, predict the magnitude and develop and rehabilitation strategy.

Determining the exact point of failure of pavement materials is usually not a simple decision, partly because pavements seldom collapse like a bridge or building. This debate goes back to a famous highway field test in the 1950s, which was conducted to determine empirical pavement life data. At some point engineers determined the pavement failed because of all the cracking. Other engineers, however, argued that more trucks could safely negotiate the pavement, therefore it was still serviceable. This difference of opinion lead to the development of the present serviceability concept of failure in highway pavements that bases failure not on cracking but on passenger riding quality. However, since aircraft ride quality is still a topic of research and is not the primary means of determining serviceability or failure at this time, there is not a direct transfer from highway pavements.

The PCI method assumes the only failure mode is that too much maintenance will be required in the future. The PCI method rewards early maintenance actions especially any maintenance action that paints over any surface distress. If maintenance actions are to

shown in Figure 2, the operations and maintenance departments can share data to benefit each other. For example, in the United States at an air carrier airport, operations personnel are responsible for daily inspections of runway and taxiway pavements, to search for discrepancies which might cause aircraft damage or disruption. These are recorded in logs and later maintenance work is assigned to make immediate or future repairs to these discrepancies. When repairs are to be made, maintenance personnel must coordinate with operations personnel to have permission to close the taxiway or runway to aircraft traffic.

In nearly every airport in the United States, neither operations personnel nor maintenance personnel can access the other's database, nor does either have the precise location information of the discrepancy. In my experience, this cross-coordination is usually attempted by telephone or radio and is often poorly communicated. Maintenance crews and contractors approved for repair work often have difficulty locating precise areas on a runway or taxiway. Significant anecdotal evidence exists about repair crews who conduct tests or core samples or make repairs in the wrong precise location but the right general area.

By having Differential Global Positioning System in operations and maintenance vehicles and GIS information available to the vehicles, inspectors and maintenance personnel can determine several types of information. They can determine if a pattern of previous discrepancies is occurring; if and when a discrepancy was previously reported; when it is scheduled for remedy; what windows of opportunity exist for runway or taxiway closure; and what other runway or taxiway closures are scheduled. GIS serves as the tool for integrating operations and maintenance data that is geographically tagged to a specific location. Later the pavement management section can also review this history of data to determine if there is an underlying reason for this pattern of discrepancies. By analyzing environmental data, aircraft loading history and pavement construction history by geographical location, a pavement management system can be a much better predictor of future problems. Significant resources can be saved if the root cause of the problem is determined and remedied rather than continuous treating of the symptoms.

## **LIMITATIONS OF TRADITIONAL PAVEMENT EVALUATION**

In the 1970s the U.S. Air Force developed a repeatable method of calculating a pavement condition index (PCI) that considered only surface distress of airfield pavements. The purpose of the index was to develop a method to assist in the allocation of maintenance funds among several different airfields. This system calculated a total deduction value, which was then subtracted from 100 points for a perfect pavement. In those times, computer power was limited to a mainframe computer and the distresses were all reduced to deduction values based upon the density of distress observed, the severity of distress and the relative importance of the distress to remaining life as determined by a survey of maintenance engineers. Because of the limitations on computing power, the actual types of distresses are not considered only the deduction value of the distresses. In the 1980s the Air Force updated the PAVER program to run on microcomputers, and therefore renamed the software MicroPAVER. Soon, the Federal Aviation Administration endorsed MicroPAVER as an acceptable pavement management system for airfield pavements. Unfortunately, some of the world's busiest airports still believe that MicroPAVER is an acceptable pavement management tool at their airport.



Robert Harrison and Michael McNerney<sup>2,3</sup> have proposed that the full costs of the operational impacts be calculated for all critical sections of pavement and used to justify exotic rehabilitation options when the delay costs indicate savings. They call this an Enhanced Pavement Management System (EPMS) that provides better management of assets and less user delays. An Enhanced PMS is location-driven and is best implemented with GIS technology and integrated with delay modelling such as SIMMOD.

Currently, no airport is actively developing a formal enhanced PMS. Some airports are using delay costs to analyze alternative reconstruction schedules, for example comparing closing a runway every night for two years to total closure for six months. However, using the Integrated Airport GIS technology and an effective pavement management system, provides the foundation for an Enhanced PMS.

Airport pavement engineers are struggling to do what is best for the airport and at the busiest airports EPMS would provide tools that will save the airlines money in the long run. However, the long-range spending forecast of an airline is probably only 6 to 12 months. However, there are airports that have not only endured the first step of actually implementing GIS technology for pavement management. There are at least two airports that are endorsing the integrated airport GIS concept of an integrated information management system with geospatial components.

## **EXAMPLES OF AIRPORTS DEVELOPING INTEGRATED AIRPORT GIS**

### ***Orlando International Airport***

David Tamir of the Greater Orlando Aviation Authority has the charge of developing an information management system that manages the configuration of the airport in all respects. In his recently published paper,<sup>4</sup> he states that the technical information management system includes a geographical information system as a major part of the overall system. CAD is also integrated into the overall system. The system is currently in the first stage of development and is likely to have a pavement management component.

### ***Inchon International Airport, South Korea***

Inchon International Airport is a new airport under construction as a replacement to Kimpo International Airport in Seoul, Korea. The airport construction phase includes a design for a modern networked information management system which is essentially an

---

<sup>2</sup> McNerney, M. T. and Robert Harrison, "Full-Cost Approach to Airport Pavement Management," Handbook of Airline Economics, First Edition, Darryl Jenkins Editor, McGraw-Hill, 1995, pp. 121-130, copy available at <http://www.utexas.edu/research/ctr/aviation>.

<sup>3</sup> McNerney, Michael T., and Robert Harrison, "Enhanced Pavement Management Systems for Airports: A Full Cost Analysis of Operational Impacts," 25<sup>th</sup> International Air Transportation Conference Proceedings, ASCE, Reston, VA, June 1998, pp.496-510.

<sup>4</sup> Tamir, David, G. Draper and R. Osborne, "Airport Configuration Management Using a Technical Information Mapping System (TIMS)," 25<sup>th</sup> International Air Transportation Conference Proceedings," ASCE, Reston, VA, June 1998, pp. 303-318.

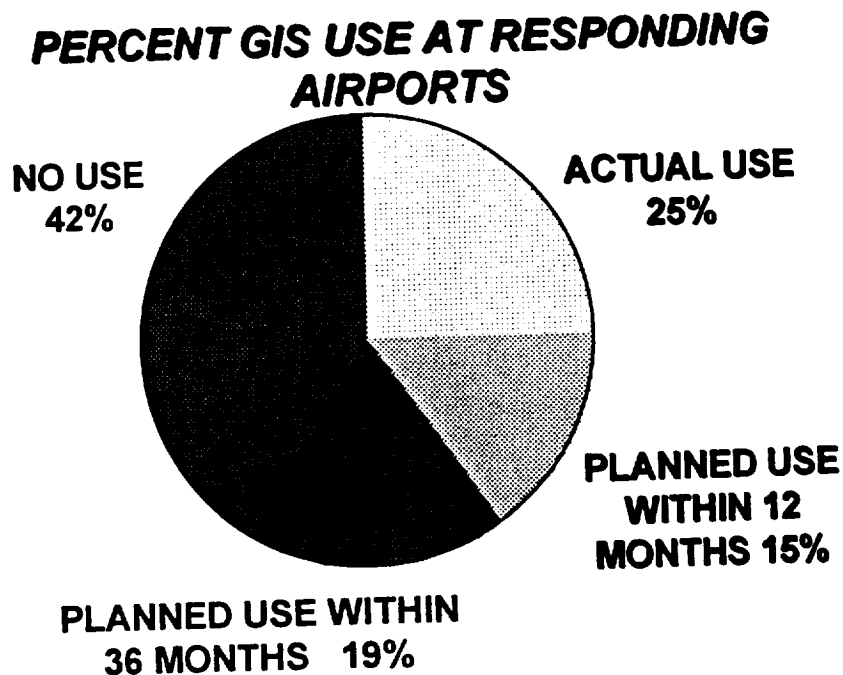
be considered as a failure mode, it is best to track the maintenance actions by geographic location, analyze the causes, and predict future requirement based upon scientific investigation rather than on a number between 1 and 100.

In one busy airport, a certain highly trafficked taxiway required the full attention of one or more maintenance crews every night. Maintenance had no system to track how much time and money was being spent on specific locations of highly trafficked sections and consequently waited far too long to convince the engineering department to let a contract for replacement of the concrete slabs. As anecdotal evidence that differences of opinions still exist today about remaining life, an engineer in another department stated that he agreed that the taxiway had reached failure, but the runway still had a long way to go to reach that failure. The maintenance foreman replied that if that engineer proposed to let the runway deteriorate to the same extent as that taxiway, he was willing to quit now. The maintenance department without the system to track locations of discrepancies and maintenance action by precise location can not successfully argue for adequate budgets or prepare plans for timely rehabilitation or reconstruction.

The ideal pavement management system will use DGPS to precisely locate and track individual discrepancies, repairs, core samples, deflection measurements, and subgrade strength measurements. It will have the ability to track non-pavement data such as aircraft traffic by aircraft type, airport drainage patterns, future rehabilitation or reconstruction projects by exact location and schedule. Using this pavement management system, control sections can be carefully monitored as indicators of potential problems before they occur.

The traditional method of PCI starts with a clean sheet of paper each year for field measurement. If the exact locations and descriptions and distress types are geographically located in the pavement management computer, the annual update can be accomplished much faster by comparing the previous data to actual existing conditions. If one of the thousands of patches on a runway were previously located by DGPS, it probably has not moved; what is important on this inspection is how the patch is performing. Also, an inspection with automatic location by DGPS and computer input in the field has less chance for errors than a manual system that transcribes field notes.

Taking another step forward into the 1990s can enhance ideal pavement management with the consideration of the actual dollar amount of user cost associated with delays caused by runway and taxiway closures. Currently, airport pavement engineers do not have a tool to measure the actual importance of any particular section of pavement with respect to operational priority. Currently, the maintenance and engineering personnel usually use the test of importance of a pavement section as best measured by how loud the operations department or airlines scream when he asks to close it for a while. In fact, the operations patterns of an airport change due to weather conditions, seasonal changes, and weekly and hourly scheduling variations. Certain portions of a long runway could be shut down for days without an operational impact if it was known that the wind patterns would require takeoffs and landings to a certain direction.



*Figure 1. Percent of GIS use at Airports Responding to Survey*

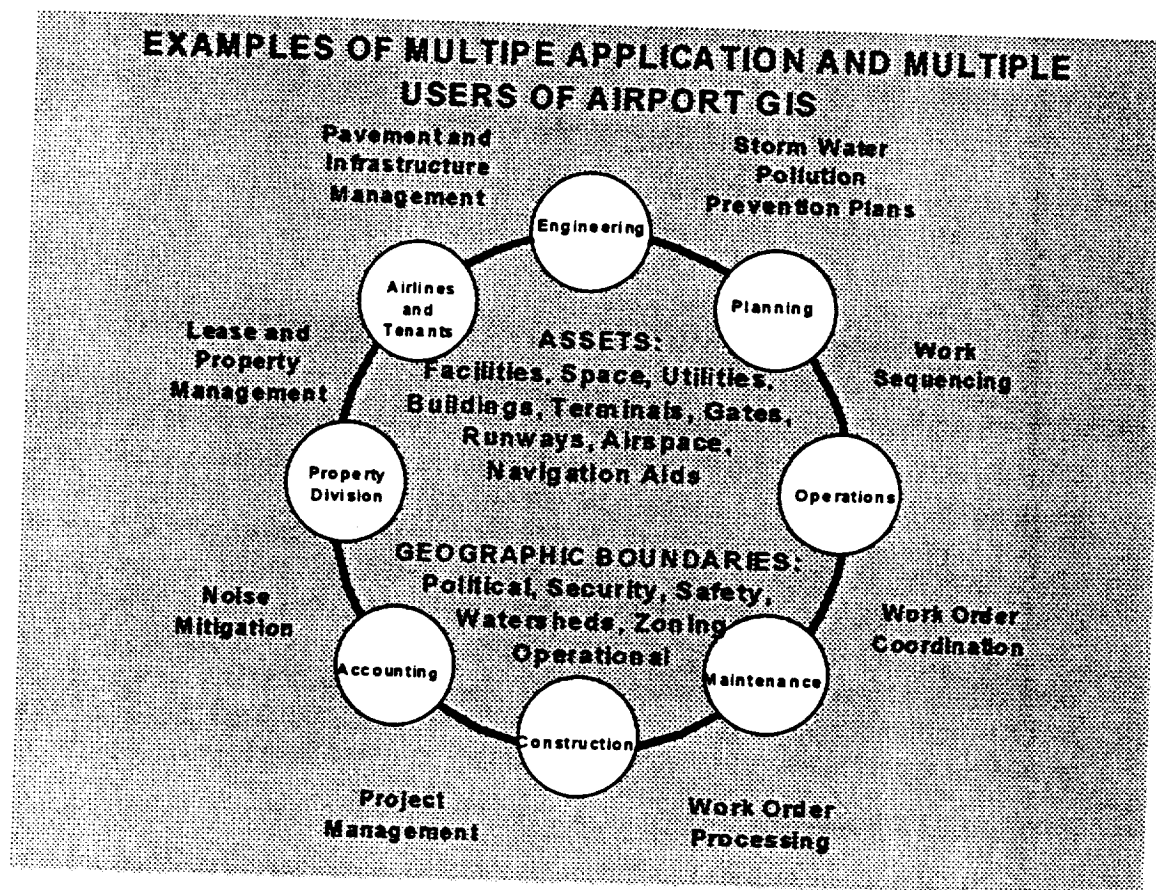
The most common scenario of Airport GIS implementation is a single desktop system purchased for a single application. This is common because money was likely available for that specific application. Often, certain types of federal grant funds or Airport Improvement Program (AIP) Funds were available for the specific purpose that a GIS could be justified. Later, as the system started to prove its usefulness, other departments wanted to add other applications to the installed system. Usually, these are added later, often to a system not designed for the necessary expansion and without a database to accommodate the new applications. This is not necessarily the best solution, and the author proposes that an Airport GIS be designed from the beginning as an integrated airport information system, not merely as a tool for a specific application.

### **INTEGRATED AIRPORT GIS**

Most accountants look at GIS and determine a cost-benefit analysis must be made in order to justify the high cost of implementation. However, when only one specific application is intended, the cost of implementing a new system from scratch seems hard to justify, simply on projected savings in budgetary dollars. In these types of traditional cost-benefit comparisons, only applications that affect the airport's revenue stream (lease space, utility customers, etc) seem to be justified on first inspection. However, the true power of a GIS is the ability to integrate data from many different sources. Several case studies at airports and municipalities have cited examples where significant savings resulted from the rapid solution to a crisis problem used GIS technology, and otherwise

would not have been solved as quickly or efficiently. Often it is a problem that was never even considered when the GIS was designed. It is hard to capture the value of the GIS problem-solving potential and value gained from having readily accessible data from a traditional cost-benefit analysis. Many people have reported that 80 percent of the cost of GIS implementation is not the hardware, software or training, but the capture of the data. In an unconventional cost benefit analysis, one should also consider the benefit gained by capturing useful data that otherwise would be lost.

An Integrated Airport GIS should be designed from the beginning to be a full service information system that shares data over networked computers for multiple applications and multiple users. Each department is responsible for the accuracy and maintenance of their data. In Figure 2, the concept of an integrated airport GIS is shown with the middle of the figure indicating some of the assets and their geographical boundaries that are shared between departments.



*Figure 2. Concept of an Integrated Airport GIS*

Examples of potential data sharing between different departments within an airport are numerous and this paper will concentrate on the pavement management and infrastructure management improvements that can be made using an integrated GIS. As

SIMILE SCANNED  
36-09  
211-274

# The Integrated Airport Competition Model, 1998

J. Veldhuis, I. Essers, Directorate General of Civil Aviation (DGCA),  
Postbus 90771, 2509 LT Den Haag, Netherlands  
D. Bakker, N. Cohn, E. Kroes, Hague Consulting Group (HCG),  
Surinamestraat 4, 2585 GJ Den Haag, Netherlands

## Summary

This paper addresses recent model development by DGCA and Hague Consulting Group concerning long-distance travel. Long-distance travel demand is growing very quickly and raising a great deal of economic and policy issues. There is increasing competition among the main Western European airports, and smaller, regional airports are fighting for market share. New modes of transport, such as high speed rail, are also coming into the picture and affect the mode split for medium distance transport within Europe.

Developments such as these are demanding the attention of policy makers and a tool is required for their analysis. For DGCA, Hague Consulting Group has developed a model system to provide answers to the policy questions posed by these expected trends, and to identify areas where policy makers can influence the traveller choices. The development of this model system, the Integrated Airport Competition Model/*Integraal Luchthaven Competitie Model* (ILCM), began in 1992. Since that time the sub-models, input data and user interface have been expanded, updated and improved. HCG and DGCA have transformed the ILCM from a prototype into an operational forecasting tool.

## 1. Introduction

The growth of air traffic at Dutch airports is a hotly debated issue in current national politics. In particular, limits on the capacity growth of Amsterdam Airport Schiphol pose a major problem because of excessive demand. Recently the Dutch government made the decision to build a new (fifth) runway. The essential question now is whether Schiphol can handle the future growth within the agreed environmental restrictions or if a new airport is needed.

Another large transport infrastructure project is the construction of high-speed rail lines. The government recently made the decision to build one of these (between Amsterdam and Antwerp, connecting to Brussels, Paris and London) and others may follow. The government is currently in search of private investors in order to the public costs of this new infrastructure. These rail lines will include a stop at Schiphol Airport and could have significant impact on long-distance travel flows to specific destinations. Policy-makers recognise that changes in one transport mode affect each of the others. This is

integrated Airport GIS that encompasses nearly all departments. This integrated airport GIS is being developed to be fully operational on the opening day as a facility/infrastructure management and operational management tool. The cost of this geographical information system as the primary information system of the airport is estimated over 15 million dollars. The integrated Airport GIS will include a pavement management system.

These are two examples of how airports are looking into the future and are developing airport-wide information systems that allow infrastructure and facility management and have geospatial analysis capability. There may be other airports that are also adopting this philosophy as well. Dallas/Worth International Airport has made a major change in policy and organization by creating a new position and hiring a Chief Information Officer at the Director level.

Recently, the American Association of Airport Executives held the first ever Airport GIS Workshop in Snowbird, Utah. The workshop was highly successful and AAAE plans to make the Airport GIS Workshop an annual event. The participants of the workshop were so enthused about Airport GIS that it was decided that an Airport GIS committee of AAAE would be formed to help promote the implementation of GIS at airports.

In comparison to state highway departments and municipalities in the United States, airports are getting a late start in GIS technology. One of the reasons for this may be the FAA and airline oversight of budgets. However, state highways departments and many municipalities typically report substantial savings in many GIS applications including pavement and infrastructure management. It is only a matter of time and education until airports begin to implement GIS technology in a big way.

due to competition as well as complementarity between modes. It is important to consider these interactions when developing new transport policy and planning tools.

The ILCM was developed in response to policy questions about the future of air transport in the Netherlands. It is based on several sub-models that act as building blocks for a comprehensive system. These sub-models correspond to each stage of the decision process for a long distance trip and include airport access mode choice, airport/air route choice, main mode choice and trip frequency models. The airport/air route and main mode choice models have recently been updated and calibrated.

The current ILCM is the result of a continuous process of improvements of the prototype system that is described in earlier papers (Bradley, et al 1992, Veldhuis, et al 1995). This paper gives an overview of the model structure, the sub-models and some examples of possible applications of the system.

## 2. Structure

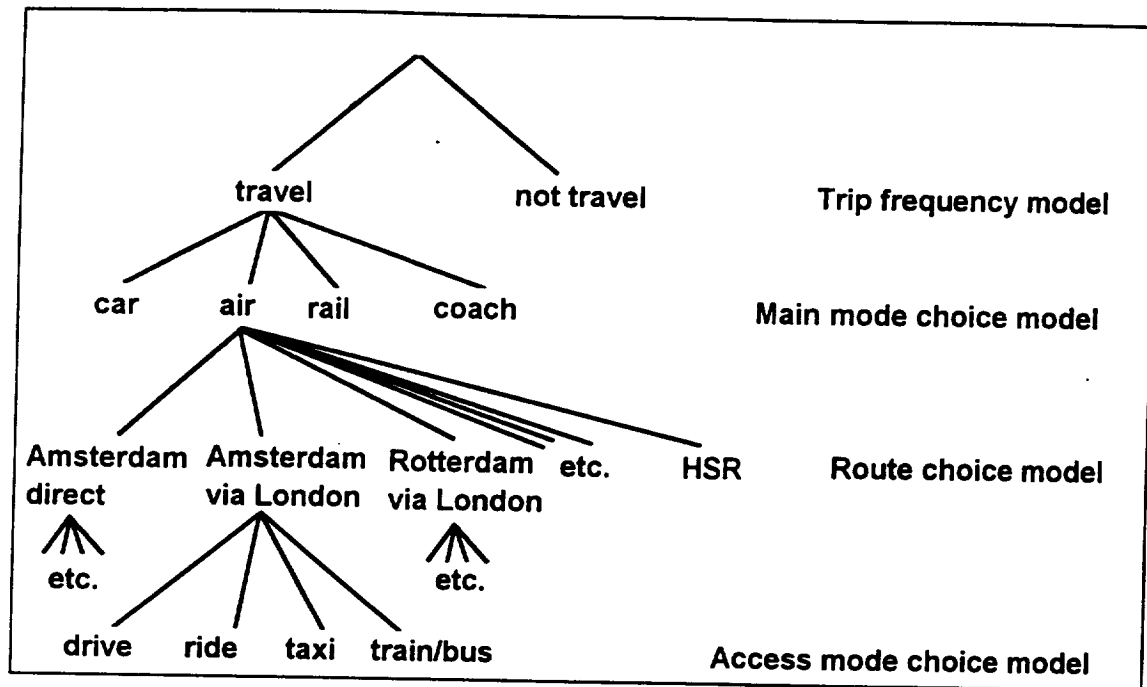
### 2.1 ILCM behavioural assumptions

Before a traveller undertakes a long distance trip, he or she makes a series of decisions. The ILCM assumes that a decision chain, illustrated in Figure 1, can reasonably represent these choices. Each decision in the chain is represented in the ILCM by a choice model.

- The first choice a potential traveller makes is whether to make the trip or not. This is represented by a *trip frequency model* in the ILCM.
- Next, he or she decides either to fly or use another mode, such as car, train or coach. This is dealt with in the *main mode choice model*.
- If a traveller decides to fly, he can often choose either a direct flight or a route that involves a transfer. Related to this is the choice between different departure airports in the area. Each airport may have different accessibility, availability of parking places, frequency of flights, etc. This part of the system is called the *air route choice model*.
- Finally, the traveller can go to the airport by public transport, by taxi, by driving and parking at the airport, or be dropped off by friends, family or colleagues. This choice is represented in the *access mode choice model*.

In the ILCM, all these dimensions of the choice process are combined in a coherent manner. A change in the frequency of flights from a certain airport, for instance, can affect all choices in the decision chain, either directly (air route and/or main mode choice) or indirectly (access mode via the choice of another departure airport).

**Figure 1: Decision chain for long distance travel**



In order to model the choices of travellers potentially making use of Schiphol Airport, the ILCM includes a market area that extends beyond the borders of the Netherlands to include Belgium and parts of western Germany. Brussels and Dusseldorf airports are likewise included as airports which compete for travellers with origins and/or destinations in the Netherlands.

## 2.2 The theory behind the ILCM

The structure of the ILCM is based on the fact that a traveller has to make a series of decisions before he or she actually makes a long distance trip. These decisions are not independent. The ILCM is a combination of models such that the choice at a lower level will influence the choices at higher levels. This is modelled by a nested or tree logit structure. The theory behind this type of modelling is described in Ben-Akiva and Lerman (1985).

The basic assumption of multinomial logit models is that people choose the option, for example the access mode, that gives them maximum utility. For each available access mode, a utility function is determined. Utility functions are assumed to be of the form

$$U^{\text{access}}(i) = \alpha + \beta \cdot \text{Cost} + \delta \cdot \text{Time} + \epsilon \cdot \text{Age} + \phi \cdot \text{Sex} + \eta \cdot \text{Travel Purpose} + \dots$$

The probability of choosing alternative  $i$  in Logit modelling can be written as:

$$P(i) = \frac{\text{Exp}(U^{\text{access}}(i))}{\sum_j \text{Exp}(U^{\text{access}}(j))}$$

where  $U(i)$  is the utility function of alternative  $i$  and summation  $\sum_j$  is over all alternatives  $j$ .

The person and travel characteristics which are to be included in the utility function are



In the nested model structure (shown in Figure 1), each choice lower down the 'tree' is conditional on the choice above it. The attractiveness of the alternatives for that choice also affects the choice that will be made above it.

The levels in the tree structure influence each other. Improvement of public transport access to regional airports, for instance, not only implies that more people who already travel via a regional airport will choose public transport as an access mode (direct effect). Also the number of travellers via regional airports will increase (first order effect), and to a lesser extent the number of air travellers overall will go up (second order effect).

This interaction between the choice levels is included in the model structure through so-called logsums. The logsum is a measure of the overall attractiveness of all alternatives at a given level of the tree structure and is computed as the logarithm of the sum of the exponential utilities:

$$\text{Log}(\sum_i \text{Exp}(U(i))).$$

In the route choice model, logsums are included from the access mode choice model for each airport. Thus, the utility function for, for instance, travel via Rotterdam airport, is described as:

$$U^{\text{route}}(\text{Rotterdam}) = \alpha + \beta * \text{Log}(\sum_i \text{Exp}(U^{\text{access}}(i))) + \delta * \text{Time} + \epsilon * \text{Cost} + \dots$$

where  $\sum_i$  is over all access modes and  $U^{\text{access}}(i)$  is the utility of travelling to Rotterdam airport using access mode  $i$ . Thus, if public transport access to Rotterdam airport is improved,  $U^{\text{access}}(i)$  increases for  $i$ =public transport; consequently the logsum for access to Rotterdam goes up, which increases the value of  $U^{\text{route}}(\text{Rotterdam})$ .

The interaction between the main mode choice model and the air route choice model is taken care of in the same way. Logsums are used for travel via all airports and using all available air routes, giving a utility function for air travel:

$$U^{\text{main}}(\text{Air}) = \alpha + \beta * \text{Log}(\sum_i \text{Exp}(U^{\text{route}}(i))) + \delta * \text{Time} + \epsilon * \text{Cost} + \dots$$

In this application,  $\sum_i$  is over all air routes and  $U^{\text{route}}(i)$  is the utility of travelling by air via route  $i$  (including departure airport choice). This means that if (for instance) tickets via Maastricht airport become cheaper, travel to all destinations by way of direct and indirect flights from  $U^{\text{route}}(\text{Maastricht})$  becomes more attractive. Also, if (for example) tickets with a transfer at London are sold at lower prices, air becomes more attractive through  $U^{\text{route}}(\text{via London})$  for all departure airports and all final destinations. In the previous example where public transport access to Rotterdam airport is improved,  $U^{\text{route}}(\text{Rotterdam})$  increases and thus  $U^{\text{main}}(\text{Air})$  also goes up.

The final interaction is that between the total number of trips and overall attractiveness of all main modes. The choice between travelling or not travelling is at this phase of the ILCM not made through logit modelling. The current ILCM models frequency by use of a fixed elasticity-based model that includes an elasticity for generalised cost.

where  $\sum_i$  is over all main modes,  $U^{\text{main}}(i)$  is the utility of main mode  $i$  and  $\epsilon$  is the main mode choice model cost coefficient ( $\epsilon < 0$ ). Improved overall accessibility (e.g. through the introduction of high speed rail, more frequent flights etc.) means that the generalised cost of travel decreases since  $\epsilon < 0$ . The elasticities therefore have the same sign as the cost coefficient to assure that a higher attractiveness of travel means that the number of trips increases. An elasticity value of, say, -0.3 means that if the generalised costs increase by 10 percent, the number of trips decreases by 3 percent. Another element of the frequency model is growth based on economic variables.

Recalling the example of improving access to Rotterdam Airport, this would decrease generalised costs through higher values of  $U^{\text{access}}(\text{Access})$ ,  $U^{\text{route}}(\text{Rotterdam})$  and  $U^{\text{main}}(\text{Air})$ , respectively. It is important to realise that the influence of a change at a certain level of the decision chain has the largest influence on the choice made at that level. The effect on higher level choices decreases with each step higher in the chain. Thus, improvement of public transport access to Rotterdam airport has the largest effect on access mode choice to Rotterdam airport, a smaller but usually measurable effect on the number of trips via Rotterdam airport, an even smaller effect on the number of air trips overall. The least amount of effect will be on the number of long distance trips made by all modes.

The models were estimated separately starting at the bottom of the tree (see Figure 1) with the access models. The process of finding the optimal set of parameters is carried out using HCG's estimation package ALOGIT. Various data sources were used for this estimation. These are described in later sections of this paper.

## 2.3 Description of the models

### Access mode choice models

The airport access mode choice models were estimated based the actual choice observed in the 1991 Schiphol survey data. For the estimation of access mode choice models for travel to the airport, nine different segments were distinguished, each having their own 'typical' travel behaviour. Five categories were developed for 'residents' (those living in the hinterland of Schiphol) and four for non-residents:

#### Hinterland residents (Benelux and west of Germany):

Business (trips longer than 2 days)  
Short Business  
Vacation  
Other Purposes  
Charter

#### Other travellers from Europe/ICA:

Business (trips longer than 2 days)  
Short Business  
Vacation  
Other Purposes

For each of these segments, separate access mode choice models were estimated. In the access mode choice models, four mode alternatives were included. They differ by residents and non-residents:

**Residents:**

Car Drop-off (car passenger)  
Car Parked (car driver)  
Taxi  
Public Transport/high speed rail\*

**Non Residents:**

Car Drop-off  
Rental Car  
Taxi  
Public Transport/high speed rail\*

\*airport access by high-speed rail (HSR) is only possible for specific airports when main mode choice is air.

The most important variables in the choice between modes are usually travel cost and travel time. All costs in these models are based on distance except for parking, which is based on duration of stay at the destination. The costs of a rental car are not included, since it is assumed that the car will mainly be used for trips other than to and from the airport. The main explanatory variables are:

- *The number of flights a traveller has made during the previous months* has a negative influence on the choice of the car passenger alternative and a positive influence on the taxi and car driver alternatives.
- *Flying to an intercontinental destination or staying away a large number of days* has a negative influence on the choice for train. Too many bags to carry might be the underlying reason. For the choice of car drop-off, this influence is positive.
- *Women are less likely to use a car* and, for the 'short' market segments, more likely to be dropped-off at the airport than men.
- *There is a strong dependence between age and the use of taxi*: the older the traveller, the more likely that he or she will travel to the airport by taxi. This effect is especially significant for the non-business segments. People over 50 are relatively often taken to the airport. People under 30 are more likely to use train and less likely to use car.
- *Scandinavian visitors use taxi relatively often*. Visitors from the United Kingdom, however, are more likely to use train. Taxi is more likely to be used by business travellers.

The values of travel time inferred from the estimated model are quite high for both business and non-business travellers. This result is typical for airport access models, since the cost of the access trip is quite small compared to the potential cost of being late for the flight.

**Air route choice models**

This model assumes that the destination airport is fixed and predicts the choice of air route to that destination, including the choice of departure airport and possibly a transfer airport. Because there was no data available in the Netherlands to estimate such model, a stated preference survey was carried out in 1992 at Amsterdam, Eindhoven and Brussels airports. The survey provided data to estimate models of the choice of departure airport and air route (direct vs. transfer) as a function of fare, frequency, travel time, access time, etc. In the SP route choice data, respondents often had the choice between travelling from the actual departure airport or switching to an alternative

airport to take advantage of a better or cheaper flight. The SP experiment and analysis are described in some detail in Bradley (1994).

Although we expect the SP data to give the best estimates of the relative importance of the variables (e.g. fare versus frequency), SP and RP data typically show different overall sensitivities (the scale of the coefficients), as well as different residual constants. It was therefore necessary to calibrate the models as much as possible to RP route choice data.

The access mode choice models are linked to the route choice models by a logsum variable that is the composite utility of access to a given airport across all available access modes.

Air route choice models were estimated for seven different market segments. Both business and non-business segments are split into "short" (major nearby destinations such as Paris, Frankfurt, London, Manchester and Copenhagen), the rest of Europe and intercontinental (ICA). Charter trips form the seventh segment.

The main variables in the model are:

- *Fare*: A linear coefficient per guilder, highly significant in all the models. The coefficient tends to decrease with journey distance, but is always 3 to 4 times as high for non-business as for business. The charter coefficient is even higher still when compared to the non-business Europe coefficient.
- *Frequency*: The logarithm of the frequency per week. For transfer routes, the lowest frequency of the two flights is used. The effect is strongest for the shortest routes, and stronger for business than non-business - particularly relative to fare.
- *Journey time*: The in-flight time plus 3 times the transfer wait time. Because there was not enough variation between flight times in the SP data to estimate a significant effect in most of the segments, the ratio of 1 to 3 was determined from the segments where an effect could be estimated (i.e., the transfer wait time is perceived to be 3 times as onerous as in-flight time). This is also similar to the ratio often estimated for wait time relative to in-vehicle time in other modes. For the short and charter flights, no effect could be estimated. For the other segments, journey time is more important for business than for non-business.
- *Transfer dummy*: Transfer routes are significantly less preferred than direct ones, even after accounting for the in-flight and wait time differences. The effect is only slightly higher for business than for non-business.
- *Airport constants*: Since we are using SP data from a choice-based sample, the constants will need to be recalibrated, so the results here are not critical. The constants for the various airports relative to Schiphol are not significant in most cases, and do not show any marked trend across the segments.
- *Access model logsums*: For application, all logsum coefficients should be in the theoretically valid range of 0 to 1.0. For some segments, the logsum coefficient had to be constrained to 1.

Our survey sample contains 985 observed choices of airports and air routes. Using those choices, an RP model was estimated of the choice between a direct or transfer route from either Amsterdam, Eindhoven or Brussels airport. In addition, information on passenger volumes at the different airports within the Hinterland was used to ensure a realistic distribution of passengers among these airports. This information was provided by DGCA and the CBS report '*Statistiek van de Luchtvaart*' (1994).

The airport/air route models were adjusted at several levels prior to implementation. The models for the Business Short and Non-business Short segments do not have coefficients for journey time or transfer dummy. No observations in these segments transferred during their trips by air, which is to be expected, and so no transfer dummy could be estimated. While an effort was made to estimate journey time coefficients for these segments, the results were not significant. It is desirable to include journey time and a transfer dummy in these models so that future policy and network changes have an effect on air travel in these segments. Therefore, in the ILCM application, the values of time estimated in the Business Europe and Non-business Europe segment models were used together with the fare coefficients in the Business Short and Non-business Short segments to estimate journey time coefficients. Similarly, the "values" of transfers in the Europe segments were used to estimate transfer dummies for the Short segments.

### **Main mode choice models**

In 1995 HCG investigated a source of information called the European Travel Monitor (ETM). The ETM is a collection of different surveys across Europe and includes trip-level information across purposes, travel modes and destinations. Because of inconsistencies between these surveys and the very high cost of the data, HCG and DGCA obtained only the data concerning long-distance trips made by residents of the Netherlands in 1994. In theory the ETM files obtained by HCG include a representative sample of these trips. Because of serious interpretation problems it was not possible to determine the proper weighting of the records. However, there were enough unweighted observations to proceed with estimating main mode choice models.

As described earlier, the access models are linked to the route choice models, and the route choice models are linked to the main mode choice models. The link from the route choice models to the main mode choice models consists of a logsum term for the airport/air route choice.

Separate main mode choice models were estimated for four market segments:

- Business Short: business trips to London, Paris, and nearby portions of Germany
- Business Europe: business trips to the rest of Europe
- Non-business Short: non-business trips to London, Paris and nearby portions of Germany
- Non-business Europe: non-business trips to the rest of Europe

These are the same market segments for which airport/air route choice models were estimated, with the exception that no models were estimated for business or non-business travel to intercontinental destinations. The reason for this is that travellers to these destinations are assumed to have no main mode choice: they must travel by air.

Four main mode alternatives are offered:

- air or HSR (highly competitive, high quality connections – see section 2.4)
- train (low comfort level)
- car
- coach

Some assumptions had to be made to incorporate the attractiveness of charter flights into the models, because it is not clear when the air alternative is charter for a given destination. According to the Schiphol survey, the main charter destinations are Spain, Portugal and Greece. For estimation purposes it was assumed that all non-business trips to these destinations fall under the charter route choice segment. A separate logsum coefficient for charter was necessary to deal with the fact that the charter and scheduled air route choice logsums are of different orders of magnitude.

Almost all of the important destinations in Europe for trips from the Netherlands have unique characteristics that are determining factors for mode choice. Because the UK is an island, a much larger share of trips with UK destinations use air as main mode than might be expected on the basis of, say, distance. France is an important destination for particular types of holidays, such as camping. This is reflected in the dominant use of the car as main mode. Car is more important for very long distance trips (to southern France, for example) than might be expected. Non-business trips to Switzerland and Austria are clustered in the winter, which is to be expected. Again more of these trips are made by car than would be expected on the basis of distance. It may be that because winter destinations tend to be far from airports and that a high number of local train transfers are required (with sports equipment being carried), many travellers choose to use a car.

The main variables in the main mode models are:

- *Air route logsum:* Theoretically for application the logsum coefficient should be in between 0.0 and 1.0. For non-business the coefficient is lower than for business.
- *Cost:* A linear coefficient per guilder. Highly significant for non-business purposes.
- *Travel- and wait time:* For non-business short the wait time coefficient is 2.5 times the travel time coefficient. For longer distances this ratio is 6.3 for non-business and 10.0 for business. For business short the ratio is set to 3.0 because it was not possible to estimate a separate wait time coefficient.
- *Duration variables:* For longer trips car is more likely to be taken, because of multiple destinations. For business trips shorter than six days, air is more likely to be chosen. Bus is less attractive for business trips shorter than three days and holidays longer than two weeks. This has to do with the amount of time and comfort relative to the duration of the trip.
- *Season:* Car is more likely to be taken in summer. For non-business air is less likely to be taken in summer for European destinations and bus less likely in the winter.
- *Age:* As expected younger and older people tend to use more public transport than

*Long distance:* For non-business Europe shorter than 750 km car is more likely. This are people travelling from the southern Netherlands. For non-business short the train is less likely above 750 km.

The low number of business observations in the ETM resulted in statistically weak time and cost coefficients for the business segments, but these still provide acceptable values of time.

**Table 1: Main Mode Values of Time**

Segment	time coefficient	cost coefficient	value of time	number of observations
Business Short	-0.001755	-0.002788	f 37.77	275
Business Europe	-0.002143	-0.002317	f 55.49	258
Non-business Short	-0.004176	-0.01016	f 24.66	2119
Non-business Europe	-0.002413	-0.005874	f 24.65	7028

### Calibration of the model system

The Schiphol Survey is used as the main source of data for the ILCM. This survey contains some 100.000 interviews per year amongst all passengers departing from Schiphol, including transfer and charter passengers. As this survey contains only air trips from Schiphol, this data could not be used in the ILCM directly to provide a representative sample of all long distance trips. Therefore, the ILCM model system creates a synthetic database based on the Schiphol Survey.

The creation of the synthetic sample was done using the models that are implemented in the ILCM to infer the number of relevant trips *not* observed in the Schiphol Survey. The underlying assumption is that if for a certain trip from a known origin and to a known destination, the model gives probability  $\alpha$  of using air from Schiphol, this trip represents  $1/\alpha$  trips between this origin and destination departing from all airports and using all modes. If, for instance, 100 vacation trips are observed between Gouda and Marseilles departing from Schiphol, and the model gives probability 0.25 that such a trip will go by air from Schiphol, we can infer that there have been 400 trips in total from Gouda to Marseilles. Of those, 300 are either using another airport or going by road or rail. The redistribution of these remaining unobserved trips is also done using the probabilities from the ILCM models.

Problems with the ETM data made it impossible to estimate models using weighted, expanded observations. In addition, lack of data necessitated using the same models for residents of the Netherlands as for non-residents. As a result, extra calibration of the main mode models was required in order to obtain a realistic base year main mode split.

This calibration is based on three data sources:

1. *Prognose des Personenverkehrs in Europa bis zum Jahr 2005*, tabellenband (IFO Institut für Wirtschaftsforschung);
2. *Vakantie van Nederlanders 1996* (CBS);
3. *Buitenlandse toeristen in Nederland 1993/1994* (CBS).

The calibration data sources show that residents of the Netherlands and residents of other countries do not have identical main mode choice behaviour. Because we use the same main mode models for residents and non-residents, it was necessary to introduce an extra penalty for all non-Hinterland production zones in Europe (except in the case of UK and Ireland).

During calibration it appeared that the main mode models for business purposes, when compared to the non-business models, had unexpectedly high train and/or coach shares for Switzerland/Austria, Spain, Portugal and Italy, which needed to be corrected.

**Table 2: Main Mode Choice final calibrated model**

Destination	air	car	train	coach	total
Germany	16.2%	66.6%	7.7%	9.4%	100.00%
UK	45.0%	35.3%	8.6%	11.2%	100.00%
Ireland	82.6%	13.7%	1.7%	2.0%	100.00%
France	10.2%	63.8%	9.5%	16.4%	100.00%
Denmark	54.2%	39.2%	1.9%	4.6%	100.00%
Sweden/Norw.	64.3%	22.9%	5.0%	7.8%	100.00%
Finland/Ice.	72.6%	21.4%	0.4%	5.5%	100.00%
Switz/Austr.	20.8%	57.6%	6.0%	15.6%	100.00%
Spain	53.4%	22.5%	3.2%	21.0%	100.00%
Portugal	83.1%	8.3%	0.8%	7.8%	100.00%
Italy	37.4%	36.6%	10.0%	16.0%	100.00%
Greece	86.0%	6.0%	5.9%	2.1%	100.00%
SE Europe	72.8%	17.0%	3.3%	6.9%	100.00%
East Europe	36.7%	45.8%	5.5%	12.0%	100.00%
ICA	100.0%	0.0%	0.0%	0.0%	100.00%
total	46.3%	37.0%	5.8%	10.9%	100.00%

In particular, the mode shares for the destinations Denmark, Switzerland/Austria, Portugal and Greece are quite different in the calibrated results.

*Germany:* The targets from the available data sources could not be used directly, because a part of Germany is Hinterland and can not be seen as a destination.

*France:* According to the two CBS data sources, residents of France travelling to the Netherlands have a significantly different mode split from residents of the Netherlands travelling to France. In particular, the air mode has a much higher share among French than among Dutch residents.

*Scandinavia:* The uncalibrated models did not adequately reflect the very high air share for these origins/destinations which appears in all three calibration data sources.

*Switzerland/Austria:* The uncalibrated models underestimated the air share to these destinations, largely because the ETM sample included a large number of winter holiday travellers to these countries going by car. This was not a good representation of non-Dutch residents from this zone travelling to the Netherlands.

*Italy:* The high mode share of train and coach was caused by trips from non-Dutch Hinterland origins, i.e. Belgium and Western part of Germany.



## Trip frequency models

The market growth models in the ILCM are based on general economic indicators, changes in the level of service (defined as the sum of the utilities of the main mode model) and an exogenous trend. Four market segments are defined:

- business direct and negative transfer
- non-business direct and negative transfer
- business positive transfer
- non-business positive transfer

The market growth model is multiplicative and consists of the following factors:

- *change in generalised costs*: growth factor =  $(e^{(\text{new logsum} - \text{base logsum})})^{\text{elasticity}}$
- *income growth*: (for non-business) expressed as an index, based on the input GDP growth over the base year for the given scenario;
- *trade growth*: (for business) expressed as an average index for the production and attraction side of the journey
- *exogenous trend*: expressed as an index

The elasticity for generalised costs and trade growth can easily be changed with the user interface. The default generalised cost elasticity is set to 0.1 for non-business and 0.0 for business. These values are based on experience with other models developed by HCG, but sensitivity tests of the ILCM were used to determine them.

In the current version of the ILCM, the positive transfer market has a choice of air and combined HST/air routes. Positive transfer passengers are not permitted by the ILCM to choose transfer airports other than Schiphol, or to travel by modes other than air. One of the results of this structure is that, given the current market growth models, any change in air level of service can result in extreme changes in the size of the positive transfer market. For this reason we have not included generalised cost in the positive transfer market growth calculations.

The business elasticity with respect to trade was estimated to be approximately 0.8.

The DGCA provided income elasticities for various time periods based on a standard Euro 1 scenario<sup>1</sup>. The income elasticities are not applied exactly as they appear in Table 3. A single income elasticity value is used. This single elasticity is calculated as follows:

1. an income elasticity is calculated for each year between 1990 and 2030 by interpolation based on the original values shown in Table 3;
2. the ILCM base year is 1994 and the new ILCM forecast year is 2020; a single income elasticity for the period 1994-2020 is calculated by averaging the interpolated values across the period 1994-2020.

**Table 3: Income elasticities for Euro 1 scenario**

	1990	2015	2030
<b>Eur- Eur</b>	1.35	0.9	0.7
<b>Eur- ICA</b>	2.5	1.35	1.1

The average income elasticity for 1994-2020 that is applied in the ILCM is **1.04** for intra-European travel and **1.71** for Europe-ICA travel. This elasticity is applied to the total income growth over the entire forecast period.

## **2.4 High-speed rail in the ILCM**

High-speed rail (HSR) has an impact on the travel choice on two levels: as an access mode and as a main mode. As an access mode, HSR is treated as a fast train. Introducing HSR as an alternative means that the access by train to relevant airports improves. HSR can be used as an access mode from specific zones to four airports in the ILCM: Schiphol, Brussels, Dusseldorf and Antwerp. As a main mode, HSR is included as a separately defined, high quality travel alternative.

During the course of ILCM development, there was much discussion by HCG and DGCA about exactly how high speed rail should be incorporated in the model system. Evidence from other studies indicates that there is much stronger competition between HSR and air travel than between HSR and any other mode<sup>2</sup>. In addition, several studies have incorporated the idea of 'air-rail integration'. This integration entails a single-ticket trip made by a combination of HSR and air with a 'seamless' transfer at a HSR station located at an airport. 'Integration' means that the traveller experiences no difference in service level (reservations, baggage handling, etc.) between the HSR portion of the trip and the air portion. In other words, the HSR segment of the trip is the same as the segment travelled by airplane, except that the HSR travels on the surface. The HSR travel time is also comparable to air travel time for many destinations when considering the high speed together with shortened access/egress time.

The ILCM includes HSR as a main mode by considering HSR routes to be alternative "air" routes. This means that HSR is treated as an extension of the air mode. No explicit choice between HSR and other modes takes place in the main mode models. Instead, the determination of whether a trip is made by HSR depends on the route choice.

Three types of HSR connections are incorporated in the ILCM:

- a trip made with a direct HSR route without any transfer
- a trip made by HSR with a transfer from one train to another (longer distance)
- a trip made using a combination of HSR and air segments.

The origin and destination of a given trip determine the availability of HSR as a route alternative. For example, from Amsterdam to Paris, HSR may be an attractive alternative. A person making a trip from Amsterdam to New York could take HSR to Paris and fly from there to New York. It is unlikely, however, that someone would take HSR to Paris and then fly to Marseilles. In the current version of the ILCM, HSR may

---

<sup>2</sup> See, for example, the study by M. Goh and E. Savolberg, "Monitoring the effects of the Thalys high speed

be used as the main mode for trips with destinations in Europe. The combination for HSR and AIR is only available for intercontinental trips. For each destination only one HST or HST/Air alternative route is modelled.

The incorporation of HSR into the airport/air route choice model entails not only the use of a file of HSR routes but also the definition of 8 extra "ports", or HSR stations. Each origin zone has access to a maximum of three HSR stations (including possible HSR stations at selected airports). Depending on the corridor of the destination, South, East or North, one HSR station is selected.

Positive transfer trips, which have origins and destinations outside the Hinterland but transfer at Schiphol may use high-speed rail for one part of their routes. In the ILCM, the choice between air routes and HSR routes for positive transfer trips is determined by the route choice models. While the introduction of new HSR routes, as well as new air routes, could change the transfer location of the positive transfer trips (from, say, Schiphol to Frankfurt), the current version of the ILCM does not model this. The change in competition between airports is not part of this model. The positive transfers in the ILCM are based on 1994 information from the Schiphol survey. The only changes to these trips in the ILCM are made in the market growth model, based on economic changes, and route choice models.

In the ILCM, positive transfer trips are constrained to using Schiphol. One result of this is that they can only use HSR if they transfer at Schiphol, also for direct HSR connections. This is a limitation placed on the ILCM to avoid processing large and complex air and HSR networks and may be removed in future versions of the system.

For transfers originating outside Europe with destinations outside Europe, HSR is not an option. The market growth model is executed for these trips, but not the route choice model.

## 3.0 The ILCM in detail

### 3.1 Market definitions

The main area of interest for Dutch policy makers is, of course, the demand for use of Dutch airports. The passenger markets for Schiphol and the regional airports of Rotterdam, Eindhoven and Maastricht form the context in which the model system is developed. HCG and DGCA recognised that the catchment area for these airports does not consist solely of the Netherlands, but stretches beyond country borders.

Three different areas were identified for the model system:

- 28 zones in *the Hinterland*, which is the area from which Dutch airports can reasonably be used as ports of departure for residents and visitors. It contains the Benelux and the western parts of Germany. In addition to the four Dutch airports, three competing departure airports in the hinterland are taken into account: Brussels, Antwerp and Dusseldorf.

- 22 zones in *the Rest of Europe*. This is the area that can be reached from the hinterland by air and by the competing land modes. The full model structure applies here. Important European airports such as London, Paris and Frankfurt are not considered as possible departure airports, but are taken into account as possible transfer airports en route.
- 15 zones in *the Rest of the World*. These destinations can only be reached by air from the hinterland, and thus the main mode choice model is not relevant for these areas. The choice of air route is more often an important issue for intercontinental travel. One can often reach these destinations either via the main European airports or via other key hubs such as New York or Singapore.

### 3.2 Travel included in the ILCM

Travel between the origin zones in the hinterland and the destination zones outside the hinterland is represented in the ILCM, along with travel from origins outside the hinterland to destinations within. Shorter trips with both origin and destination within the hinterland are excluded - these trips generate very little air travel. Some trips with both origin and destination *outside* the hinterland can be important for the hub airports; these transfers account for a substantial fraction of the passengers using Schiphol airport. The transfer market is included in the ILCM but the choice behaviour of this market is not modelled as completely as that of the non-transfer market.

Transfer trips can be split into two categories: positive transfers and negative transfers. Positive transfers are made by passengers originating outside the Hinterland, changing planes at Schiphol, and continuing on to a destination outside the Hinterland (Europe or ICA). Negative transfers are defined as trips made by passengers originating *inside* the Hinterland, changing planes at an airport outside the Hinterland (other European zones) and continuing on to a destination outside the Hinterland (Europe or ICA), *when a direct route from the Hinterland to the destination exists*.

The specific types of travel alternatives included in the ILCM are outlined in Table 4.

**Table 4: Hinterland-Europe/ICA alternatives**

Alternative	Access Mode	Departure Airport	Transfer Airport	Main Mode
Direct Air	*	*		*
Indirect Air	*	*	*	
HSR / Air	*	**	**	
HSR	*	**		
Train				*
Coach				*
Car				*

\*: Predicted by the ILCM

\*\* : The HSR route alternative is pre-defined

Departure Port in Hinterland, Transfer Port outside Hinterland

Table 4 shows that a long distance traveller can choose between either a land mode or an air mode. In the future it is expected that HSR will allow convenient transfer to air at the major Western European airports, so it is treated as an air mode for our purposes. For all air modes, a traveller can choose between different access modes to get to the departure airport, which is one of the airports in the hinterland. For HSR, which in the ILCM has a limited number of departure stations, an access mode is also be predicted in

the decision chain. An air and/or HSR traveller can either travel directly (by air or HSR) or indirectly via a transfer airport. This is predicted by the air route choice model. For modelling purposes, we currently assume that the transfer airport is outside the hinterland, although in reality a small number of Schiphol passengers do change flights at Brussels or Dusseldorf, both of which are in the hinterland. The large majority of transfers, however, are via hub airports such as London, Paris, Frankfurt, Copenhagen and Madrid.

Note that at the destination end of the trip, the choices of arrival airport and egress mode are not modelled. Although these are also decisions that the traveller may have to make, they are not very relevant for local policy purposes. Also note that the models deal exclusively with outbound trips leaving the hinterland, although the ILCM does take into account whether those trips are made by residents or by visitors returning home. We implicitly assume that the choices for the inbound trips are symmetric, i.e. that the traveller will return by the same mode, and that an air traveller will return to the same airport.

### **3.3 Inputs to the ILCM system**

Used in this way, the model system is essentially a pivot point procedure that predicts changes in demand for Schiphol Airport. It can also provide estimates of changes in demand for competing modes and airports, but these will clearly be less accurate than those for Schiphol for which we have accurate base data.

In addition to the demand database, the supply side inputs are very important for the model system to function properly. These inputs include travel times, distances and, for some modes, cost and transfers between origins and destinations. For the development of the ILCM, several data sources were used. Access mode travel times and distances to airports were derived from the National Model System (LMS). For road and rail in Europe, new European main networks were created to derive shortest paths. For air travel times and frequencies, the ABC Guide database was used that contains details for all scheduled flights serving the possible departure and transfer airports. Air fares were based on regression equations derived from a sample of actual fares. The main variables in the regressions are distance and fare class, with some variations allowed by destination region (e.g. higher fares to Scandinavia).

For the HSR a kind of default level of service is created. This means that the travel times are based on a full operational HSR network, the frequency is set to 10 times a day and the prices are set equal to the air fares. From this point by the user interface it is easy to define specific scenarios. Fare changes can be made for combined HSR/air travelling separate from the air fares. Assumptions have been made about HSR check-in and transfer times in combination with air travel. For within Europe, check-in time for HSR trips is set at 5 minutes except for UK destinations, for which a 30-minute check-in is required (more restrictive border controls). Transfer times are equal to check-in times. For Hinterland-ICA combination routes, check-in is set at 90 minutes and transfer to air at 60 minutes. This compares with 60 and 120-minute check-in times for air within Europe and to ICA zones, respectively. Air-to-air transfer time is 60 minutes. While "integration" of ticketing between HSR and air is implicit in the assumption of interchangeable routes, no special integration of trains with airline check-in is assumed.

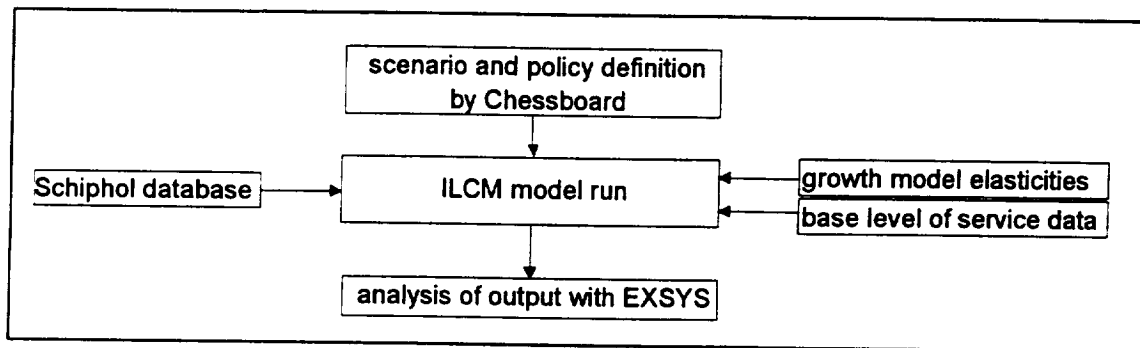
### 3.4 The ILCM user interface

HCG has developed a new ILCM user interface based on the specifications provided by DGCA (Jan Veldhuis). The ILCM user shell has been developed to allow users of the ILCM to perform the following:

- specify two types of modifications to model inputs: “scenario” and “policy” changes;
- apply (run) the model system
- view output results in the EXSYS program.

The structure from the user's perspective is shown in Figure 2.

**Figure 2: ILCM application structure**



For the scenario specifications the Chessboard (see Figure 3) allows the user to specify aggregate or disaggregate changes on the main level of service variables. The user modifications of these variables are organised into two categories: scenario changes and policy changes. Scenario changes are meant to be background changes in economic growth and national transport regulations, while policy changes are meant to be policies implemented directly by the user of the ILCM (such as DGCA). Policy changes can also be specified as additional tests beyond the changes in a standard forecast such as 'Global Competition' (CPB 1997).

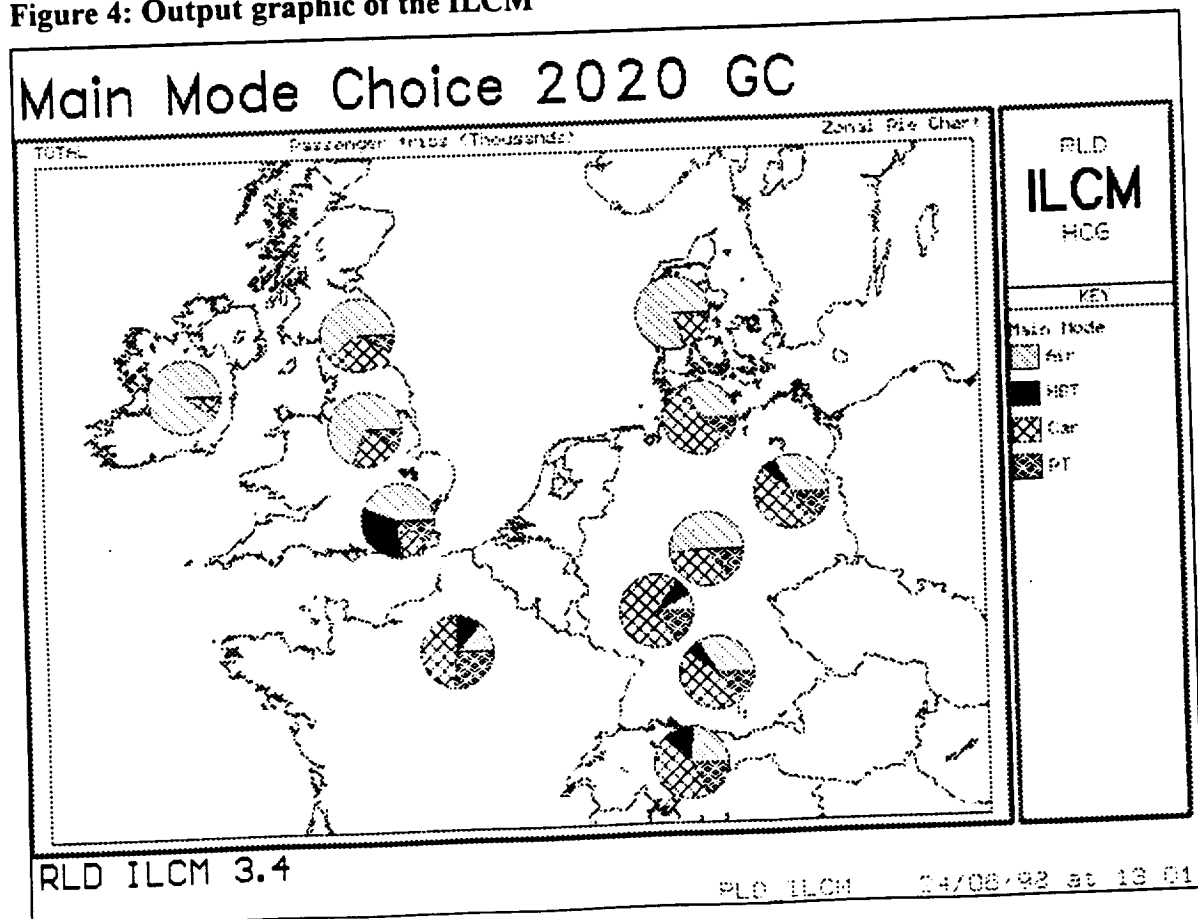
The tool to analyse the result of ILCM runs is called EXSYS. With Exsys it is possible to compare different scenarios in a standard way. In addition to tables, it is possible to create graphical output in EXSYS. This may be in the form of bar or pie charts as well as in the form of simple maps. Below two examples of EXSYS graphics output are shown.

Figure 3: Chessboard

		MAIN MODE				Access mode		
		Air	HST	Train	Car	Train	Car	HST
Economy	70							
Fares (scenario)		B1	B2	B3	B4	B5	B6	B7
Frequencies (scenario)		C1	C2	C3		C5		C7
Travel times (scenario)			D2	D3	D4	D5	D6	D7
Trend	20							
Fares (policy)		F1	F2	F3	F4	F5	F6	F7
Frequencies (policy)		G1	G2	G3		G5		G7
Travel times (policy)			I2	I3	I4	I5	I6	I7

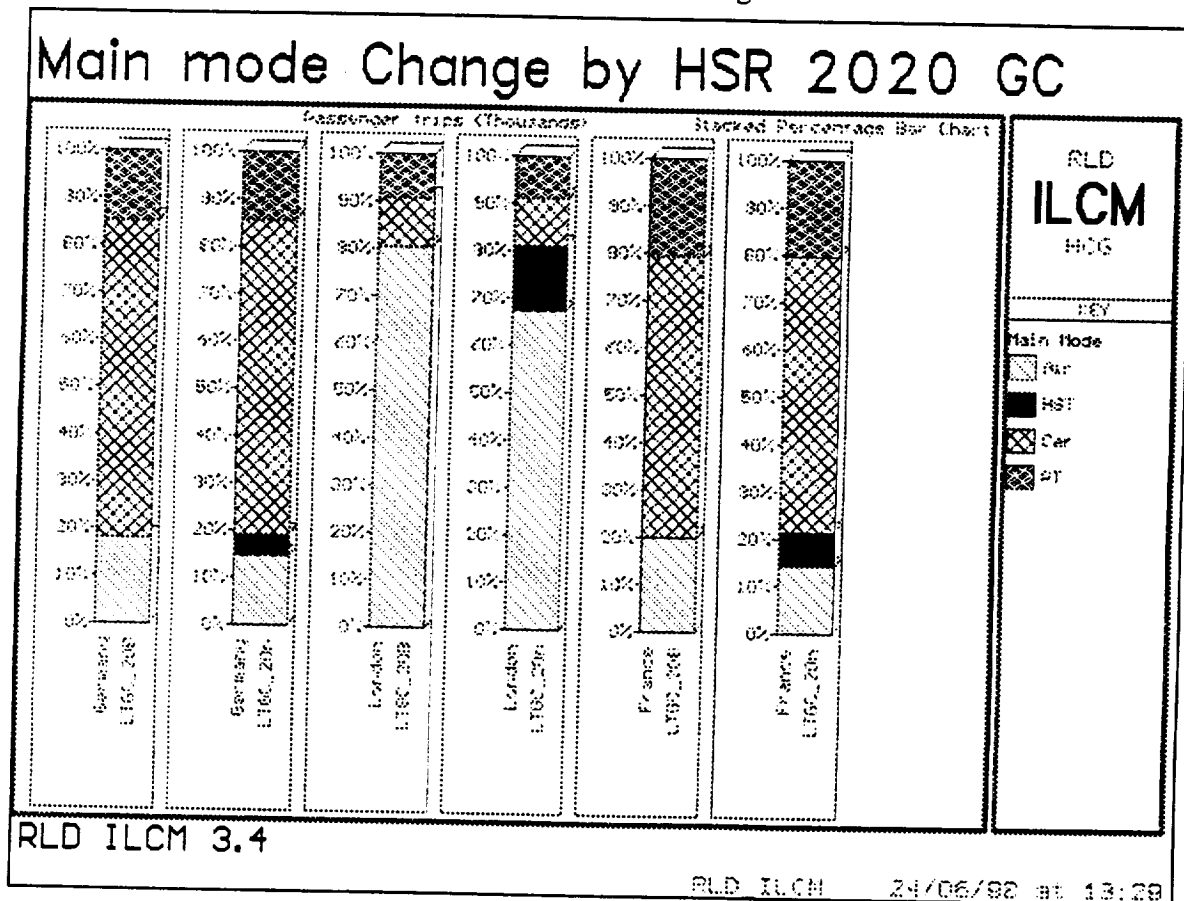
F6 Exsys F7 Clr F8 Chge F9 Run Enter Mod. F10 HST Alt-X Done AltF10 Elas

Figure 4: Output graphic of the ILCM



The graphs shown here are based on the Global Competition forecasts made for the Centraal Planbureau (1997). Three different scenarios were defined: Divided Europe, European Co-ordination and Global Competition. This resulted in forecasts for passengers from Schiphol and HSR-substitution of between 57 and 90 million and 3.8 and 6.4 million trips, respectively. The graph in Figure 5 shows that there are also HSR travellers attracted from car and train modes. The bars in the second graph show, respectively, the GC scenario without HSR and with HSR East and South fully available for relevant destinations. The German and French destinations are aggregated.

**Figure 5: Main mode choice for trips with Dutch origins**



## 4. Future model development

The ILCM provides analysis of Amsterdam Airport Schiphol in relation to surrounding, competing airports and competing surface travel modes. While it is highly developed in terms of estimating total *passenger* travel demand, main mode choice and air route choice, it does not yet provide any information relating to freight. The ILCM's demand forecasts are not capacity-constrained, nor do they provide data on aircraft movements. The next phase of ILCM development is likely to include the incorporation of new modules for freight demand, aircraft movements and fleet composition.



## 5. References

Ben-Akiva M. and Lerman S. (1985), *Discrete Choice Modelling: Theory and Application to Transportation Planning*, MIT Press, Cambridge, MA;

CBS (1995), *Buitenlandse toeristen in Nederland 1993/1994* Centraal Bureau voor de Statistiek, Voorburg/Heerlen;

CBS (1997), *Vakantie van Nederlanders 1996*, Centraal Bureau voor de Statistiek, Voorburg/Heerlen;

Centraal Planbureau (1997), *Economische en fysieke omgeving Beleidsopgaven en oplossingsrichtingen 1995-2020*, SDU uitgevers, Den Haag.

Ettema, D. with N. Cohn and F. Savelberg, 'Monitoring the effects of the Thalys high speed train', to be presented at PTRC, September, 1998.

European Travel Monitor, European Travel Data Center S.A.

IFO (1996), *Prognose des Personenverkehrs in Europa bis zum Jahr 2005*, tabellenband, IFO Institut für Wirtschaftsforschung, Munchen.

Veldhuis J., Bradley M., Brouwer M. and Kroes E. (1995), *The integrated Airport Competition Model, A Model System for International Long Distance Passenger Transport*, WTRC 1995, Sydney;

SINGLE SCAN

S7-09  
04/10/98  
CLOSE

## Airport Competition - Myth and Reality

Presented By:

Mr. Tom Haughey, Aer Rianta Group Strategy Manager

UCD Conference, July 1998

## The Public Policy Framework

The majority of European airports are state or city owned enterprises. It is appropriate then to view the growing importance of competition in the airport business within the framework of a changing public policy perspective. This perspective which is becoming increasingly popular, at both State and EU levels, views airports and state enterprises generally, as being essentially monopolistic businesses and, therefore, advocates a change to a more entrepreneurial approach, with clear objectives, greater efficiency, accountability and better value for money. The means of achieving this change are seen as inherent in a private sector approach to management, with a focus on competitiveness, responsiveness and performance.

There is an important European aspect to this policy debate. The EU advisory group on competitiveness chaired by former Italian Prime Minister Carlo Azeglio Ciampi submitted a report in 1995 which recognised that without a stronger, competitive basis in the fields of energy, public transport and telecommunications, the European economy would find itself at a disadvantage. The group considered the various experiences of restructuring and the introduction of competitive pressures into various public utilities, and decided that "what matters most is not so much that the ownership and management of public utilities moves from the State to the private sector, as that competition is introduced and extended wherever possible". This is an important distinction. Rather than simply recommending the importation of a private sector approach to traditional public sector business, as a means to a more competitive end, Ciampi saw the primary concern as the introduction of more competitive processes, regardless of whether a business existed in the realms of the public or the private sector. To be in one sphere or the other was not necessarily seen as an impediment to effective and efficient operations.

In light of this, the challenge for airport management is to ensure that balance is maintained between competing tensions. It must ensure that values such as efficiency and professionalism, which are driving the shift towards competition, are incorporated into its approach, whilst preserving traditional values such as due process and integrity. In the face of increasing competitive pressures it is also important to ensure that inappropriate policy initiatives, which are engendered by the more challenging environment and pose significant threats to the efficient management of airport enterprises, are avoided.

## Competition at Airports

As the internal European air transport market is liberalised and air service agreements with non-EU states become less restrictive, competition between European airports has increased dramatically. This is mainly due to the fact that, apart from high-demand hubs such as Heathrow and Frankfurt, many airports can no longer count on having a captive market. Airlines, passengers and freight forwarders can choose between airports, and passengers and cargo may also choose to utilise other forms of transport e.g. high speed rail.

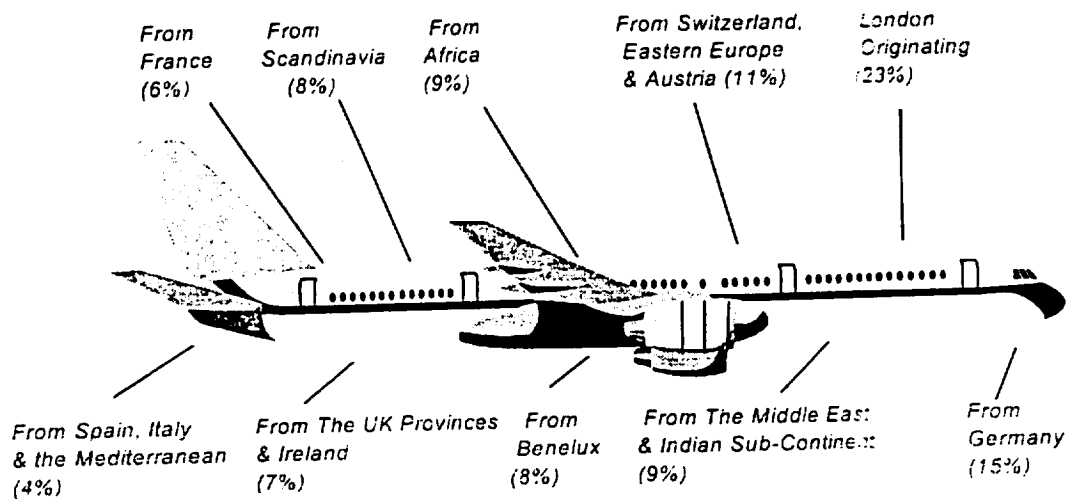
We can identify several different forms of competition between and at airports viz.:

1. Competition for a role as a hub airport and for transfer traffic between hubs
2. Competition to attract new airline services - passengers and freight
3. Competition for the provision of services at airports
4. Competition between airports with overlapping hinterlands
5. Competition between airports within urban areas
6. Competition between airport terminals

## Competition For A Role As A Hub Airport and for Transfer Traffic Between Hubs

Development as a hub has major economic and revenue generating implications for airports. As a result, competition to attain and maintain hub status is fierce. In Europe alone, London Heathrow, Frankfurt, Paris CDG and Amsterdam Schiphol all have their own plans to cater for the growth in air traffic through the provision of appropriate infrastructure and the development of new routes.

Transfer traffic is an essential element in the development of airport hubs. Such passengers are also vital to the success of airline global scheduled service networks, as the passenger composition of any long haul-flight will show. Less than a quarter of the passengers on a recent flight from Gatwick to Dallas originated from the London area, the remainder transferred from a myriad of other originating points.



Source: British Airways News, 19th July 1996

Transfer traffic represents approximately 45% of passenger traffic at hubs such as Frankfurt and Copenhagen, 40% at Amsterdam and 30% at London Heathrow. Put in perspective, more passengers transfer between flights at Heathrow or Frankfurt than arrive at or depart from Zurich Airport each year.

As the number of airline groupings declines through such developments as global alliances and code-sharing, the opportunities for airports to attract hub traffic and gain the resulting benefits in terms of route development will reduce. Airports cannot compete for transfer passengers through ticket pricing strategy (prices are obviously controlled by the airlines). In addition, they are largely dependant on the operating strategy of the home airline to bring in transfer passengers. However, successful airports have demonstrated that they can influence passengers choice of routes and carriers by exercising their control over key factors such as minimum connect times, transfer systems, flight schedules, and passenger services.

## Competition to Attract Airline Services

Historically airports tended to play a passive role in the development of their air services, sitting back and waiting for the airlines to arrive. However, many airports have now recognised the substantial benefits which can be gained through marketing and increased competition to attract airline services has been the primary result of this trend. Airports are now taking a leading role in initiating interest among the airlines, for both passenger and freight services. This activity usually entails undertaking market research, route forecasts and sometimes financial evaluations in order to identify the most attractive routes for airlines to operate.

Competition to attract new airline services has also led to airports offering support through joint promotional campaigns and, in some cases, reductions in airport charges. Competition for new long haul services is particularly keen.

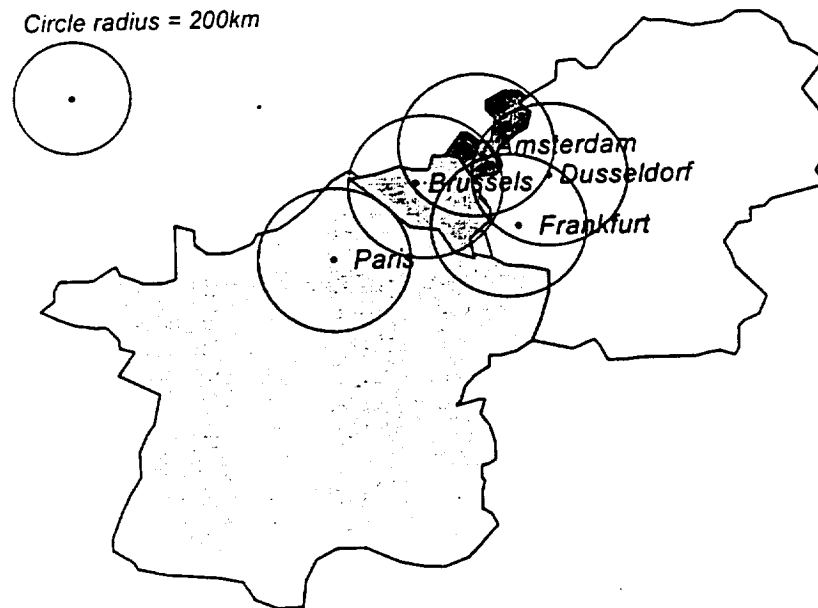
## Competition for the Provision of Services at Airports

The principle of transparency which has long been advocated in the awarding of public service contracts is now being extended to the airport environment. Airport users rising concerns with regard to the "contestability of markets" has meant that services which were traditionally carried out by the airport authority or one of its subsidiary companies (e.g. ground handling and catering) are increasingly becoming subject to public tender. The new competitive environment has also meant that airport management must also be extremely careful with regard to its relationships with the providers of services.

The way in which an airport service is provided (i.e. either by the airport authority or by a third party) and whether there are competing services will clearly impact on the airport's competitive position in both price and quality terms. It will also affect revenue and cost levels and the level of investment needed. The liberalisation of ground handling services at European airports, for example, is having a particularly significant effect on revenues and employment at many airports.

## Competition Between Airports With Overlapping Hinterlands

Most major cities tend to be located at least 200 kms apart. As a general rule, the shorter the distance to the next city and the more equal in size its airport, the greater the portion of hinterland overlap and the greater the competition between the airports. Examples include East Midlands/Birmingham: Brussels/Amsterdam: Milan/Turin and Manchester/Liverpool. The slide illustrates the extent to which hinterland overlap is experienced by some Northern European airports. Amsterdam Schiphol have estimated that 65-80% of its passengers have a choice between airports.



Many countries are working towards making their airports effective parts of high speed rail networks. The impact of these moves will be to expand the extent of airport hinterlands and hinterland overlaps further into the regions - Paris CDG has a high speed train station and can be reached from Lille (210km), Tours (240km) and Reims (200km) within one hour. A journey from Nantes (440km), Bordeaux (580km) and Strasbourg (490km) can be achieved in less than two hours. Furthermore, airlines concentrating on hub development see rail connections as another form of spoke mechanism and thereby an effective means of strengthening their hubs - KLM have studied this for the development of their Schiphol hub. Thus, airports which may have viewed themselves as having clearly defined geographic hinterlands all to themselves, are increasingly finding that their territory is being encroached upon as a result of the increasing integration of transport modes, thereby forcing them to compete against airports which they might never have viewed as competitors in the past. Clearly, Dublin competes with both privately owned Belfast airports in this way - competition which can only intensify as the road network between Dublin and Belfast is upgraded to motorway standards.

Finally, the time element of the flight can have an important bearing on the extent of hinterland scope. Passengers on short haul flights are more inclined to depart from the airport nearest to them, whereas those on long haul flights are willing to travel further to connect to it, if, for example, a competing airport can offer a better airline service or a more direct routing.

## Competition Between Airports Within Urban Areas

Relatively few cities in the world have more than one airport and in cities where this does occur it is often the case that the airports are owned by the same company, for example Aeroports de Paris owns Paris/CDG, Paris/Orly and Le Bourget; the Port Authority of New York and New Jersey owns the three New York airports - JFK, La Guardia and Newark.

Examples of competing airports in the same urban area include Belfast (Belfast City Airport and Belfast International) and Washington (Washington Dulles and Washington National), while to a lesser degree, Luton and London City compete with the BAA's London airports. Overall, however, the experience in managing multi-airport systems indicates that carriers are extremely reluctant to fly to a new or second airport without being forced to do so by the regulatory authorities. The advantage in terms of traffic demand at the primary airport can persist for decades, e.g. in making its case for access to Heathrow slots for its transatlantic services in 1990, Virgin produced data to support its contention that average yields on routes from Heathrow were some 15% higher than those available at Gatwick. Indeed carriers and passengers are so wedded to the primary airports at cities that many administrations and airport authorities actually close an old airport when they develop a new one to ensure the viability of the new facility e.g. Denver, Oslo. An exception to this was the case of Montreal's Dorval Airport which was not closed when the new airport, Mirabel, was opened in the 1970's. Over two decades later, Transport Canada was forced to close Mirabel to scheduled services following the carriers determined opposition to transfer from the older facility. One can only speculate as to what will happen in Milan over the next few years following the Italian authorities recent decision to compel carriers to move from Linate to Malpensa airport where heavy investment in facilities has just been completed. The transfer is being fiercely resisted by the airlines and is being challenged in law by those concerned.

A recent proposal for a second, independently owned airport for Dublin was turned down by the Irish Government in 1996. One of the bases for this decision was that the international experience of two airport cities indicated that a second airport in Dublin would not be effective. Issues such as duplication of infrastructure and facilities, problematic traffic transfer between the airports, higher costs and problems for route integration and hubbing were cited as not supporting the case for a second airport for Dublin.



## Competition Between Terminals at Airports

The situation where the airfield owner does not own and operate some, or all, of its terminals is rare in Europe. Recently, however, airport privatisation has increasingly been touted as one way to fulfil the need for new funding sources, whilst simultaneously providing increased efficiencies. A potentially damaging aspect of this debate is the tendency of media commentators to suggest that competition between terminals at airports would promote efficiency and reduced cost, without producing any supporting data or arguments other than a mantra that competition is good for all, in all situations. On the level of the debate to date, one could argue for two Lee Tunnels or two East Link bridges as being in the interests of efficiency.

Lack of single ownership and control at airports can result in serious problems for strategic planning and for financial and operations management. Excess capacity must be created in order for competition to take place with the resulting higher costs necessarily passed to airline customers. Apron and safety management issues can be difficult to overcome. Finally, such approaches have often introduced a degree of rigidity to the airport situation when what is needed in the increasingly competitive environment is more management flexibility.

Examples of airports where there was some semblance of competition between terminals are John F. Kennedy Airport in New York and Pearson Airport in Toronto. In the case of the former there are self evident problems in relation to airport management and development, particularly regarding access transport and funding for long term developments.

In the latter case, a scarcity of capital and inadequacies in the running and development of the airport led the Government of Canada to seek the participation of the private sector in the provision of a third terminal at Toronto's Lester B. Pearson International Airport in 1986. That decision set in motion a process which resulted in arrangements whereby T3 was financed, designed, constructed, managed and operated by an independent private sector developer, Claridges, under a long term ground lease.

The T3 experience led the government to attempt to follow the same privatisation route for the redevelopment and refurbishment of the two older terminals at Pearson in 1990. The attempt subsequently collapsed following a general election campaign, amidst allegations of bid rigging, patronage, undue political influence, excessive lobbying and claims that the project was not in the public interest. A Government enquiry was subsequently set up to examine what happened at Pearson over the decade up to 1996 at which the CX of the T3 investment company, Claridges, recorded that his group would not have got involved in Terminal 3 if they had not expected to obtain management rights over Terminals 1 and 2 in due course. This looks like an admission that Claridges were looking for a low cost route to ownership and control of Pearson.

In December 1996, control of Pearson was transferred from Transport Canada to the Greater Toronto Airports Authority (GTAA), a not-for-profit company controlled by the local authority. GTAA aims to proceed with expansion plans for the airport, including the development of a unified modern terminal building to replace Terminal 1 and ultimately Terminal 2 as passenger traffic demands. On April 1st 1997, the Greater Toronto Airports Authority made an agreement to purchase Terminal 3 at Pearson for \$719 million (\$199 million more

than it cost to build five years before). The prevailing view seems to be that Canada's foray into creating inter-terminal competition between the public and private sectors caused more problems than it solved. There now appears to be consensus in Canadian aviation circles to have the entire airport under one ownership and control.

"The government has recognised that rather than lease airport facilities in a fragmented manner, it is more effective to lease the entire airport asset as a unified operation.....the purchase of Terminal 3 by the Authority removes the last remnant of the earlier privatisation philosophy and is, in my view, consistent with the latest thinking in airport management."

(Louis Turpen, GTAA President and CEO).

There are two current examples of proposals to provide competition between terminals which are worth noting - the cases are in relation to the proposed development of Terminal 5 at Heathrow and of Huntstown at Dublin Airport. The recent MMC Report on the BAA rejected proposals by a company calling itself Enlightened Competition which suggested that the construction and operation of Heathrow's Terminal 5 should be subject to public tender, whilst both the Minister for Transport, Energy and Communications and the County Council refused the Huntstown proposal for a second terminal at Dublin Airport on some very strong grounds in May of 1997. In essence, their view was that the best way to grow Dublin Airport is to maximise existing facilities. They also felt that Huntstown was not in the best interests of Dublin Airport, that it was premature, lacked adequate services and access, and was in the wrong location.

## Conclusion

Public policy trends, both at EU and member state level, would appear to be moving in the direction of introducing competitive pressures into areas of the EU economy which have been traditionally isolated from them in the past. Airports appear to be prime targets in this drive.

As a result, airport managers, can reasonably expect various policy initiatives to arise in relation to the issue of competition at airports in the future. Some of these initiatives could well be unsuited to the efficient and effective management of airports. It is therefore most important that airports be closely involved in aviation policy development, especially in the light of inappropriate policy decisions made elsewhere which have hindered the efficient management of airports.

Aer Rianta welcomes the increasing focus on competitiveness and efficiency and is confident that all objective assessments of these measures will confirm that it is at the forefront of European airports in regard to the competitiveness of its airport charges, return on investment, cost of providing capacity increases, manpower efficiency etc. Aer Rianta's strengths have been proven through the success it has achieved in the highly competitive international business in which it is engaged and commentators who are prepared to explore beyond the level of the sound bite should be able to ascertain these facts for themselves.

The Air Transport Research Group of the WCTR Society was formally launched as a special interest group at the 7<sup>th</sup> Triennial WCTR in Sydney, Australia in 1995. Since then, our membership base has expanded rapidly, and now includes over 400 active transportation researchers, policy-makers, industry executives, major corporations and research institutes from 28 countries. It became a tradition that the ATRG would hold an international conference at least once a year. In 1998, the ATRG organized a consecutive stream of 14 aviation sessions at the 8<sup>th</sup> Triennial WCTR Conference (July 12-17: Antwerp). Again, on 19-21 July, 1998, the ATRG Symposium was organized and executed every successfully by Dr. Aisling Reynolds-Feighan of the University College of Dublin. The Aviation Institute at the University of Nebraska at Omaha has published the Proceedings of the 1998 ATRG Dublin Symposium (being co-edited by Dr. Aisling Reynolds-Feighan and Professor Brent Bowen), and the Proceedings of the 1998 WCTR-ATRG Conference (being co-edited by Professors Tae H. Oum and Brent Bowen).

# REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)

2. REPORT DATE  
December, 1998

3. REPORT TYPE AND DATES COVERED  
Monograph Report

4. TITLE AND SUBTITLE

The Symposium Proceedings of the 1998 Air Transport Research Group (ATRG)

5. FUNDING NUMBERS

NAGW-4414

6. AUTHOR(S)

Aisling Reynolds-Feighan & Brent D. Bowen (Eds.)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Air Transport Research Group  
c/o Tae H. Oum, Van Dusen Foundation  
Logistics & Public Utilities, Univ. of British Columbia  
2053 Main Mall  
Vancouver, CANADA V6T 1Z2

8. PERFORMING ORGANIZATION  
REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

University of Nebraska at Omaha Aviation Institute  
NASA Nebraska Space Grant  
6001 Dodge Street, Allwine Hall 422  
Omaha, NE 68182-0508

10. SPONSORING/MONITORING  
AGENCY REPORT NUMBER

98-3, 98-4 & 98-5

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

See Attached Sheet (over)

14. SUBJECT TERMS

Aviation, Airlines, Transportation, Air Transport Research Group,  
Airport Management, Airline Networks, Airline Alliances,  
Deregulation, Airfreight, Airline Competition & Financing

15. NUMBER OF PAGES  
varies

16. PRICE CODE

17. SECURITY CLASSIFICATION  
OF REPORT

Unclassified

18. SECURITY CLASSIFICATION  
OF THIS PAGE

Unclassified

19. SECURITY CLASSIFICATION  
OF ABSTRACT

Unclassified

20. LIMITATION OF ABSTRACT